DEPARTMENT OF TRANSPORTATION

Expanding the Adoption on Private Lands: Blowing-and-Drifting Snow Control Treatments and the Cost Effectiveness of Permanent versus Non-Permanent Treatment Options

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Previous research that estimated the costs and benefits of snow-fences for MnDOT in terms of a reduction in the costs of mitigating blowing-and-drifting snow problem areas (MN/RC 2012-03) demonstrated the ability of snow-fences to significantly lower those costs for MnDOT districts. To address lack of adoption, this project designed and tested an outreach program for MnDOT offices in one district and worked with MnDOT to prepare an outreach plan to promote greater adoption and cost savings in the remaining offices in the state. The overall goal is to reduce blowing, and drifting, snow problems and associated costs in the state through an effective outreach program to MnDOT district offices and through them, to landowners. The objectives of the project were to 1) carry out a pre-promotion KAP (knowledge, attitudes, and practices) survey; 2) implement a snow-fence promotion program; 3) carry out a post-promotion KAP study; 4); based on the KAP study, design an outreach plan to promote installation of snow-fences and the associated cost savings and 5) assess the market and non-market value of different permanent and non-permanent snow-fence designs.

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We would also like to recognize the important contributions of Sonya Henning of Henning Professional Services. She provided invaluable information on how MnDOT purchases land and easements from landowners to be able to install blowing and drifting snow control measures. This is an important tool for MnDOT as they deal with blowing and drifting snow problems and key to understanding potential income and tax impacts on landowners that must be understood to improve interactions with landowners.

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LIST OF ABBREVIATIONS

ADOT	Arizona Department of Natural Resources
CRP	Conservation Reserve Program
DNR	Department of Natural Resources
DOA	Department of Agriculture
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FLEP	Forest Land Enhancement Program
FSA	Farm Service Agency
HISP	Highway Safety Improvement Program
IDOT	Iowa Department of Transportation
IDT	Idaho Transportation Department
LSF	Living Snow-fence
McDOT	McHenry County Division of Transportation
MDOT	Michigan Department of Transportation
MDT	Montana Department of Transportation
MaineDOT	Maine Department of Transportation
NDDOT	North Dakota Department of Transportation
NHDOT	New Hampshire Department of Transportation
NRCS	Natural Resource Conservation Service
NYSDOT	New York State Department of Transportation
SDDOT	South Dakota Department of Transportation
SNOWMAN	Snow Management Software
SP&R	State Planning and Research
SUNY ESF	State University of New York, College of Environmental Science and Forestry

UDOT	Utah Department of Transportation
USDA	United States Department of Transportation
VTrans	Vermont Transportation Agency
WisDOT	Wisconsin Department of Transportation
WSDOT	Washington Department of Transportation
WYDOT	Wyoming Department of Transportation

EXECUTIVE SUMMARY

This project designed and tested an outreach program for MnDOT offices in one district and worked with MnDOT to prepare an outreach plan to promote greater adoption and cost savings in the remaining offices in the state. The goal was to reduce blowing-and-drifting snow problems in the state through an effective outreach program to MnDOT district offices, and through them to landowners. The project objectives were to: 1) carry out a pre-promotion KAP survey; 2) implement a snow-fence promotional program; 3) carry out a post-promotion KAP study; 4) design an outreach plan; and 5) assess the market and non-market value of different permanent and non-permanent snow-fence designs.

INITIAL KAP STUDY

This study used the KAP method to design and conduct a survey of MnDOT District 8 employees, assessing their knowledge, attitudes, and practices related to their interactions with landowners and the implementation of blowing-snow-control measures. This information was used to design the training for MnDOT staff. Analysis of the KAP survey results yielded several important considerations for designing the training: 1) Tailor the training to the two separate groups of MnDOT staff; 2) Include a review of existing snow-control measures and tools and how to use them; 3) Introduce staff to the blowing-snow-control program; 4) Highlight the ways that blowing-snow-control impacts employees' work.

OVERVIEW OF STATE SNOW-FENCE PROGRAMS

We investigated snow-fence programs in the United States including how they conduct landowner outreach. This research allowed us to identify characteristics of strong programs, common barriers, and opportunities. Characteristics of strong programs included: relationships with local landowners, direct communication, coordinated collaboration, flexibility, experimentation, funding, landowner interest in conservation or public safety, observable benefits, winter conditions, and excellent maintenance.

PROMOTIONAL MATERIALS AND STAFF TRAINING

We developed a series of promotional materials for staff to utilize when promoting blowing-snow-control. These materials included input sheets and check. In addition, based on KAP study results, we held two training workshops in Wilmar, MN, in May 2016. The training and materials incorporated the recommendations from the KAP study and MnDOT Staff.

SECOND-ROUND KAP REPORT

In January 2017 a second-round of KAP survey was conducted with MnDOT employees. The findings from the second KAP study also generated several recommendations: 1) Logistic recommendations such as: provide more time and compensation for implementing blowing-snow-control, consider experimenting with corn stalks, ensure MnDOT operations facilitate blowing-snow-control, ensure funding for snow-control, and reach out to landowners in the spring; 2) Reach landowners by making presentations in the community, using mass media, and collaborating with local organizations; and 3) Continue to review blowing snow control measures and promotion with staff trainings.

BLOWING-SNOW-CONTROL PROGRAM PARTICIPANT INTERVIEWS

Over the course of this project, MnDOT District 8 experienced a significant increase in landowner participation in its standing cornrow blowing-snow-control program. In March 2017, the University of Minnesota conducted phone interviews with six landowners who participated in MnDOT's blowing-snow-control program over the past year. These interviews provided important insights: 1) Participants had previous experience with snow-fences or a personal connection to MnDOT; 2) While money was an incentive, people also participated because they saw its benefit and wanted to help themselves and their community; and 3) Participants suggested doing more direct outreach with landowners.

ASSESSMENT OF MARKET AND NON MARKET VALUES OF SNOW-FENCES

We evaluated four options for landowners interested in establishing a snow-fence on their property. The benefit of a structural snow-fence has the largest per acre benefit because of the small footprint (25 feet wide) and the generous payment, but as is evident from MnDOT costs, it is the most expensive option for MnDOT to address blowing-and-drifting snow issues. There are also significant differences between the benefits to farmers and the costs to landowners of the different snow-fence options. Based on these results, we provided the following suggestions for MnDOT: 1) Consider raising the annual payment to farmers/landowners who establish living snow fences (LSF) to at least the same annual payment provided for standing corn rows; 2) If MnDOT is interested in the cost efficiency of the snow-fences installed, preference might be given to the LSF and standing corn row (SCR) options.

INTEREST IN HARVESTING PRODUCTS FROM LIVING SNOW-FENCES

Part of the work on this task included gauging the interest of local groups (4-H, and others) in hand harvesting corn from standing cornrows to generate funding for their activities. Generally, the response was positive with interest shown by the groups in hand harvesting corn as an income generating option to support local chapters of 4-H and FFA. Preliminary trials experienced some issues, but the option could be improved based on the experience so far. Several options for including harvestable products in snow-fences have been discussed over the years starting in the 1990's. Producing fruits, nuts, decorative woody florals (stems such as willows and dogwoods used by the floral industry), pollinator habitat are some of the options that have been suggested. Despite little interest demonstrated in alternative products in land occupied by snow-fences, it may still be an interesting and viable option for some farmers and landowners. These are the options that have received the greatest attention from research and marketing: decorative woody florals, Hazelnuts, Aronia Berry and Elderberry.

RECOMMENDATIONS FOR FUTURE RESEARCH

The KAP studies highlighted an important gap in knowledge relating to the perceptions and motivations of landowners. At this point, the main blowing-snow-control challenges faced by MnDOT are not technical, but rather they are related to the social problem of adoption. Understanding the complex social dimensions of blowing-snow-control is a necessary next step. Further research on landowner perceptions and motivations, in the form of a comprehensive and rigorous survey, will help MnDOT design new solutions and more effectively reach out to landowners.

SUMMARY

Overall, the KAP methodology that was used in this project provided an effective tool for identifying training needs of MnDOT program delivery and maintenance staff related to the MnDOT blowing-and-drifting snow-control measures. Following the training, it provided a means to gauge changes in knowledge and attitudes of those who attended trainings compared to those who had not. The way it was structured, it could be used to identify problems MnDOT staff has in promoting and implementing blowing-and-drifting snow-control measures with landowners. We used that knowledge to develop check lists and promotional materials as well as procedures for implementing control measures. Although the exercise was carried out in a single MnDOT district by design, it demonstrated a methodology that could be streamlined and used in other MnDOT districts to identify training needs for MnDOT staff involved in promoting and implementing blowing-and-drifting snow-control measures.

Throughout this effort, there were several lessons learned that will be useful as MnDOT strengthens its snow-fence program to more efficiently and effectively implement snow-control measures to improve public safety, address and reduce the incidence of injuries and deaths attributed to blowing-and-drifting snow and reduce MnDOT's costs of maintenance:

1. There is a general lack of knowledge of the MnDOT blowing-and-drifting snow-control program, which includes limited knowledge on procedures, practices, responsibilities, tools, and supervisors of the program at the state and district level.
2. Based on previous work and interviews with landowners who implemented standing corn rows during the winter of 2016-2017, there is limited knowledge of the MnDOT program among landowners who would be eligible to participate.
3. Training needs were identified based on lack of knowledge ascertained through a KAP survey and direct meetings and conversations with MnDOT program delivery and maintenance staff.
4. Based on the KAP survey and conversations with MnDOT staff, separate training programs for program delivery and maintenance staff were developed to meet the specific needs of each group. The KAP survey and KAP process provided an effective and efficient means to identify research needs and plan training as well as develop training, logistics and promotional material to improve the effectiveness of snow-fence promotion in District 8.
5. The research identified a need for information on landowner knowledge, attitudes, and practices related to blowing-and-drifting snow-control to better equip MnDOT staff in approaching landowners and promoting snow-control measures on private land.
6. The number of snow-control measures implemented on private land grew from 4 sites in 2015-2016 to 15 in 2016-2017, close to a four-fold increase demonstrating the results of the research program.
7. What became obvious because of this research program is that certain individuals from the MnDOT maintenance staff were very effective in promoting adoption of snow-control measures, while others were not. Active promotion of snow-control measures on private lands tends to be a decision of individual maintenance or program delivery staff and not a requirement. Identifying, supporting and incentivizing individuals who have an interest and ability to promote snow-control measures on private lands will be important in the future success of the program.

CHAPTER 1: INTRODUCTION

Blowing-snow-control measures reduce travel times, increase driver visibility, improve road conditions and prevent winter weather-related accidents. These measures save thousands of taxpayer dollars through avoided snowplowing, deicing and infrastructure damage (Wyatt et al, 2012). Research conducted at the University of Minnesota shows an average benefit: cost ratio of about 17:1 when utilizing living snow-fences in lieu of snow removal (CTS, 2015). Previous research that estimated the costs and benefits of snow-fences for MnDOT in terms of a reduction in the costs of mitigating blowing-and-drifting snow problem areas (MN/RC 2012-03) also demonstrated the ability of snow-fences to significantly lower those costs for MnDOT districts. Preventing snow build-up also reduces the need to apply salt, preventing chloride from draining into watersheds and harming local fish and plant life (Zamora et al, 2015). Living snow-fences also provide wildlife habitat, prevent erosion, sequester carbon and intercept runoff (Wyatt et al, 2012). However, despite these benefits and evidence that blowing-snow-control decreases costs of winter snow-control in MnDOT districts; there has been limited uptake of the state's program.

To address this challenge, in 2010 the University of Minnesota collaborated with MnDOT to conduct focus group discussions with Minnesota landowners (Wyatt et al. 2012). The study revealed that constraints to adoption include costs associated with planting, maintenance, and removal of the snow-fences as well as opportunity costs related to taking land out of production. Long-term contracts and the landowner liability to maintain fences were also identified as factors that increase the risk for landowners and make them unwilling to participate in the program. The study also identified several factors that encouraged landowners to participate in snow-fence programs including general awareness, landowners' perceptions of the program's compatibility with their objectives, incentives/compensation, and the program's relative advantage over other land-use options. The study recommended offering adjustable payments based on land-value changes over time, flexible contracts, competitive incentives, providing alternatives for maintenance, and decreasing landowner liability for fence-row death (Wyatt et al, 2012). Nonetheless there is still limited uptake of the snow-fence program, which is limiting the associated cost savings in the state.

To address the problem of lack of adoption, this project designed and tested an outreach program for MnDOT offices in one district and worked with MnDOT to prepare an outreach plan to promote greater adoption and cost savings in the remaining offices in the state. The overall goal is to reduce blowing-and-drifting snow problems and associated costs in the state through an effective outreach program to MnDOT district offices, and through them to landowners. The objectives of the project were to 1) carry out a pre-promotion KAP (knowledge, attitudes, and practices) survey; 2) implement a snow-fence promotional program; 3) carry out a post-promotion KAP study; 4); based on the KAP study, design an outreach plan to promote installation of snow-fences and the associated cost savings; and 5) assess the market and non-market value of different permanent and non-permanent snow-fence designs.

The research methodology for this project involved the following steps: 1) an initial evaluation of the gaps in knowledge demonstrated by MnDOT district personnel relative to the benefits of implementing

snow-fences. This was done using interviews and focus groups with MnDOT in the selected district; 2) design and implement a KAP study to gauge knowledge, attitudes, and practices of MnDOT staff relative to snow-fences; 3) based on the KAP survey results, design and implement a training and outreach program for MnDOT staff to teach them about the benefits of snow-fences as well as the existing programs; 4) and design and administer a second KAP survey to gauge changes in knowledge, attitudes, and practices related to snow-fences allowing us to evaluate training and outreach to design a more effective training and outreach program for MnDOT districts. In addition, we evaluated the market and non-market values of different permanent and non-permanent snow-fence designs.

CHAPTER 2: FIRST-ROUND KAP STUDY

This research expanded upon the University of Minnesota's previous study by conducting a KAP (Knowledge, attitude and practices) survey with MnDOT staff. We used the results of the KAP survey to design a pilot training program for MnDOT employees to promote blowing-snow-control measures. We designed The KAP study to gauge existing knowledge, attitudes, and practices of MnDOT staff relative to snow-fences. The focus of the KAP study process was to assess MnDOT district staff knowledge and interest in: 1) Promoting snow-fences with private landowners, 2) The use of standing corn rows or other temporary fencing, 3) The use of grading to reshape the road for snow and erosion control, 4) The use of structural or living snow-fences. The results of the KAP study describe current knowledge of blowing-snow-control measures, and the attitudes and practices of MnDOT staff in program delivery and maintenance/operations who routinely work with private landowners.

2.1 METHODS

This study used the KAP method to design and conduct a baseline survey of MnDOT District 8 employees, assessing their knowledge, attitudes, and practices related to their interactions with landowners around the implementation of blowing-snow-control measures as well as their knowledge of existing tools and procedures for implementing blowing-and-drifting snow-control measures. The KAP method has been widely used in international and public health settings since the 1930s, though it is effective in any situation in which the researcher is interested in investigating gaps in understanding about an issue in a specific population. KAP surveys can identify knowledge gaps, cultural beliefs or behavior patterns to promote more comprehensive understanding, and guide effective action. Numerous studies by Dr. Karlyn Eckman at the University of Minnesota have successfully used the KAP approach to design interventions related to environmental issues within the context of Minnesota, demonstrating the suitability of the approach in this setting (Eckman, 2013).

The KAP study began on November 17, 2015 with a small meeting at MnDOT District 8 headquarters in Marshall, Minnesota. This meeting was a facilitated brainstorming session, or "gap exercise", with six MnDOT District 8 employees from both the program delivery and maintenance sectors, aimed at identifying "what we don't know" about effective outreach and communication with landowners around blowing-snow-control adoption. After a brief overview of the study's format and goals, respondents were asked to come up with issues or questions that they had regarding the topic. Respondents wrote their comments on post-it notes, which were sorted by the group into four main categories: knowledge, attitudes, practices and other. A photo taken at the meeting, shown below, illustrates this stage of the project.

Following the meeting, all the respondents' comments were further sorted and refined by the research team. In addition to the categorization of comments into knowledge, attitudes, and practices groups, they were also sorted by "construct", or theme (for example, "awareness of blowing-snow-control practices and possible training needs" and "land tenure status"). All members of the research team including representatives from MnDOT reviewed the resulting categorizations and gave feedback on the interpretations of the comments before finally using them to develop a draft questionnaire. This

questionnaire was reviewed and pre-tested by members of the research team, as well as a member of MnDOT's blowing-snow-control program, and was distributed to MNDOT District 8 employees through the online survey software Survey Monkey on January 7, 2016.

Figure 2.1 Respondents Contributions Sorted into Four Categories

Prior to beginning social research with MnDOT employees, the research team submitted a request to the University of Minnesota Internal Review Board (IRB) for exemption from Human Subjects Research review. Exemption was granted in mid-December 2015. HSR IRB and federal law require that all data obtained in this study be kept confidential and securely stored, and that data and comments obtained not be shared or published.

In total, 31 questions were asked, including an initial disclaimer question. Question topics were split between knowledge, attitudes, and practices. MnDOT District 8 employees were notified of the survey via email, and they were given until January 25, 2016 to complete it online. A reminder email was sent out to all participating employees the day before the survey closed to encourage additional submissions.

The sampling frame included all MnDOT District 8 employees that were identified as relevant to the study, 200 individuals in total. Sixty-six individuals responded to the survey, resulting in a 33% response rate.

2.2 FIRST-ROUND KAP STUDY RESULTS

In this section of the report, the results for each individual survey question will be summarized with respondent comments considered. The answer choices with the highest response frequency for each question are highlighted in yellow. All percentages are rounded to the nearest whole percent.

2.2.1 Q1: I understand that participation in this survey is voluntary and that my answers are confidential and cannot be associated with my name. I also understand that whether I participate in the survey will not affect my relationship with the Minnesota Department of Transportation or the University of Minnesota.

All 66-survey respondents answered this introductory question. Descriptive statistics are given in Figure 2.2 below

Answer Choices	Responses
Yes, I understand and agree to take the survey	95% 63
Yes, I understand and do not want to participate in the survey	5% 3
Total	66

Figure 2.2 Participant Understanding- Descriptive Statistics

Although three respondents (5%) indicated that they did not want to participate in the survey, all respondents answered subsequent questions on the survey, and all their responses were considered in the analysis.

2.2.2 Q2: What is your job type?

64 individuals answered this demographic question; two skipped it. Descriptive statistics are given in Figure 2.3 below.

Answer Choices	Responses
Maintenance operations	56% 36
Program delivery	44% 28
Total	64

Figure 2.3 Job Type Descriptive Statistics

Responses to this question revealed that over half (56%) of survey respondents work in MnDOT's maintenance operations while a little less than half (44%) of respondents work in program delivery. Results are shown graphically in Figure 2.4 below. Because MnDOT employees working in maintenance operations and program delivery may hold different knowledge, attitudes, and practices related to snow-fences, many of the following questions in this survey are analyzed using cross-tabulations.

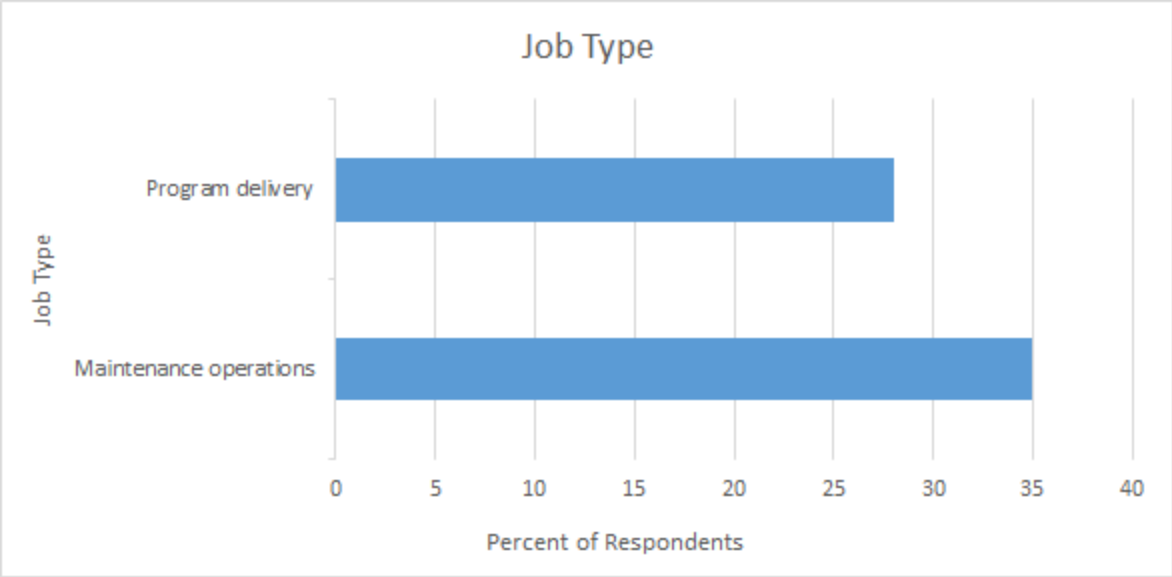


Figure 2.4 Job Type Bar Chart

2.2.3 Q3: How far removed from farming are you?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.5 below.

Answer Choices	Responses
I'm active in farming	**17%** 11
I'm not actively farming but my parents farm or were farmers	**34%** 22
My grandparents farmed but neither my parents nor I farm today	**28%** 18
My family has never farmed	**22%** 14
Total	**65**

Figure 2.5 Farming Experience Descriptive Statistics

Survey respondents most frequently reported that they are not actively farming but their parents (34%) or grandparents (28%) farmed or were farmers. Less than a quarter of respondents (22%) reported that their family has never farmed. Only 17% of respondents report that they are currently active in farming.

Figure 2.6 shows cross-tabulated data (job type x farming experience). The cross-tabulated data shows that program delivery staff are relatively more removed from farming compared to their counterparts in maintenance operations. 50% of respondents working in program delivery reported that their grandparents farmed but neither they nor their parents farm today. In comparison, over 40% of respondents working in maintenance operations had parents who farm or were farmers. Similarly, respondents employed in maintenance operations were twice as likely to be currently active in farming compared to those involved in program delivery.

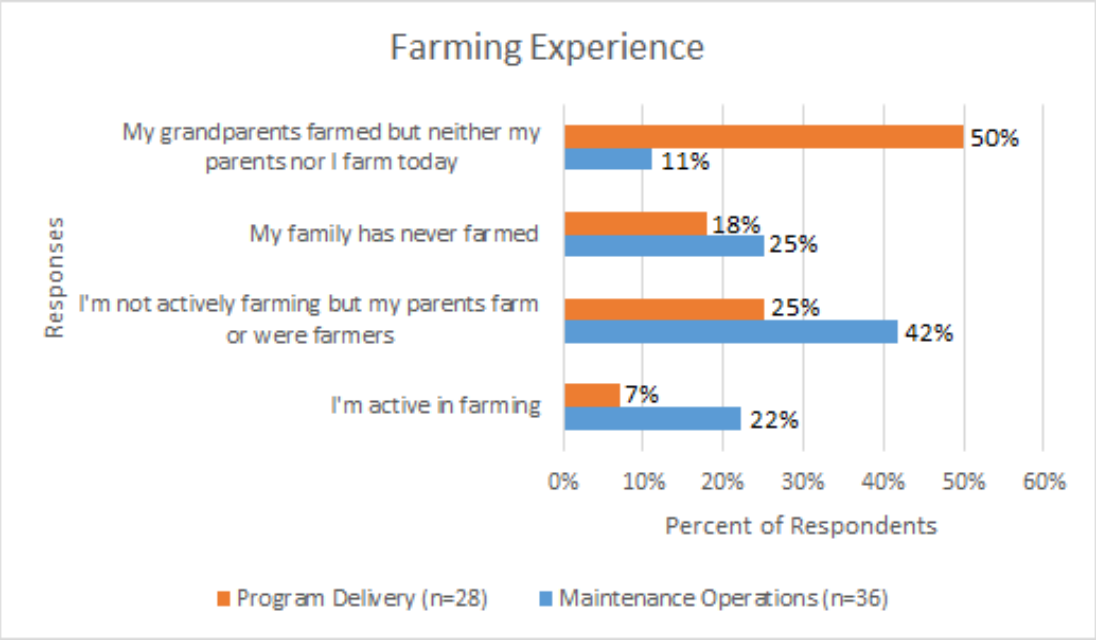


Figure 2.6 Farming Experience Crosstabs

2.2.4 Q4: If you farm, please check the box that applies the most.

62 individuals answered this question; four skipped it. Descriptive statistics are given in Figure 2.7

Answer Choices	Responses
I farm my own land	**8%** 5
I no longer farm my own land	**2%** 1
I rent my land to others	**10%** 6
I rent land from others for farming	**0%** 0
Does not apply	**81%** 50
Total	**62**

Figure 2.7 Type of Farming Experience Descriptive Statistics

Most respondents (81%) reported that this question does not apply to them. As Figure 2.7 demonstrated, only 17% of respondents are currently active in farming. The low percentage of respondents that are actively engaged in farming explains the high percentage of respondents that report that this question does not apply to them. The remaining respondents most commonly reported that they rent their land to others (10%) or farm their own land (8%). Only one respondent reported that he/she no longer farms his/her land. Figure 2.8 provides cross-tabulated data (job type x farming practices) and shows that both program delivery and maintenance operation staff involved in farming seem to have very similar farming practices.

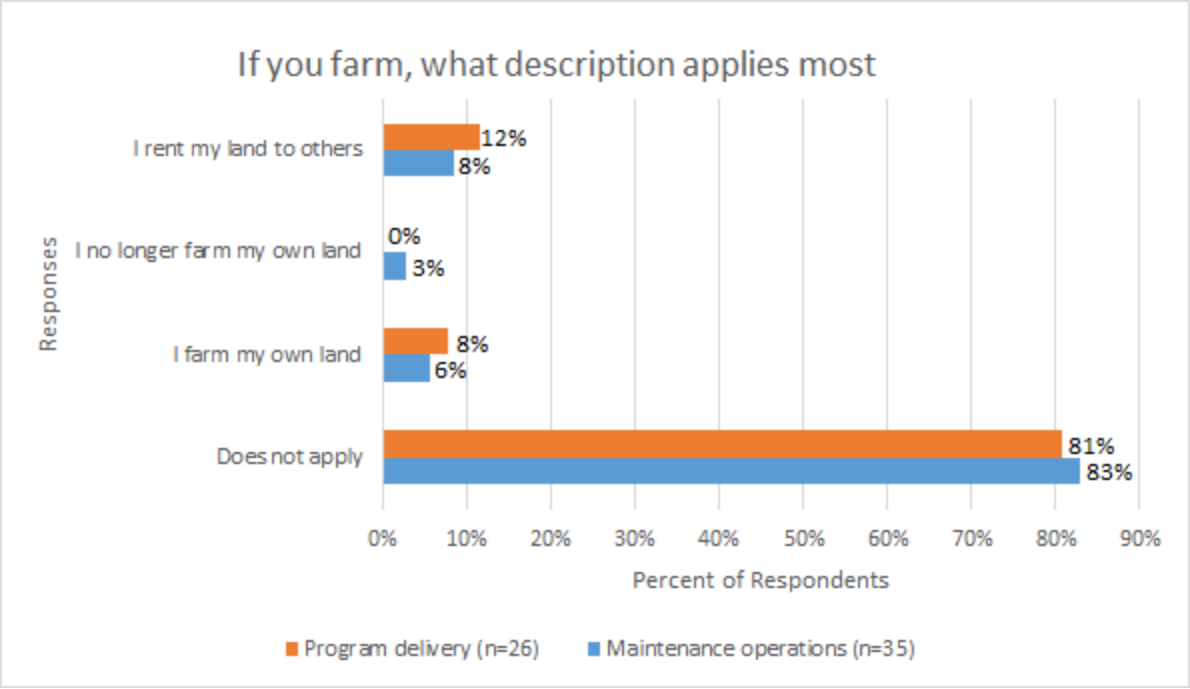


Figure 2.8 Type of Farming Experience Crosstabs

2.2.5 Q5: What are the current temporary measures used by MnDOT to control blowing-snow?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.9 below.

Answer Choices	Responses
Standing corn rows	**92%** 60
Stacked corn or hay bales	**37%** 24
Temporary snow fences (4 foot tall orange snow fence, either plastic or wood lathe corn cribbing)	**52%** 34
Mechanically wind-rowing snow in the farm field	**51%** 33
Don't know	**8%** 5
Other (please specify)	**6%** 4
Total Respondents: 65	

Figure 2.9 Knowledge of Temporary Measures Descriptive Statistics

Most respondents (92%) report that MnDOT utilizes standing cornrows as temporary snow-control measures. The next most commonly identified measures included temporary snow-fences (52%) and mechanically windrowing snow (51%). The least most popular measure was stacked corn or hay bales (37%). Only 7.89% of respondents reported not knowing any temporary measures utilized by MnDOT. In addition, 6% of respondents reported using other temporary measures such as deicing chemicals, tapered or dakota winging, making trails on the right of way, and using grasses, shrubs and trees as

snow fencing. It is notable that several survey respondents described the use of shrubs, trees and living snow-fences as a temporary measure. This may indicate a disconnect in nomenclature used for living snow-fences within MnDOT with some staff viewing these as temporary measures and others viewing them as long-term measures. Figure 2.10 provides cross-tabulated data (job type x temporary measures currently utilized by MnDOT) and shows that staff involved in maintenance operations were more likely than program delivery staff to report that they do not know what temporary measure are currently utilized by MnDOT. While program delivery and maintenance operations staff equally recognized temporary snow-fences and mechanically windrowing snow as measures currently utilized by MnDOT, program delivery staff were more likely to be aware of stacked corn or hay bales.

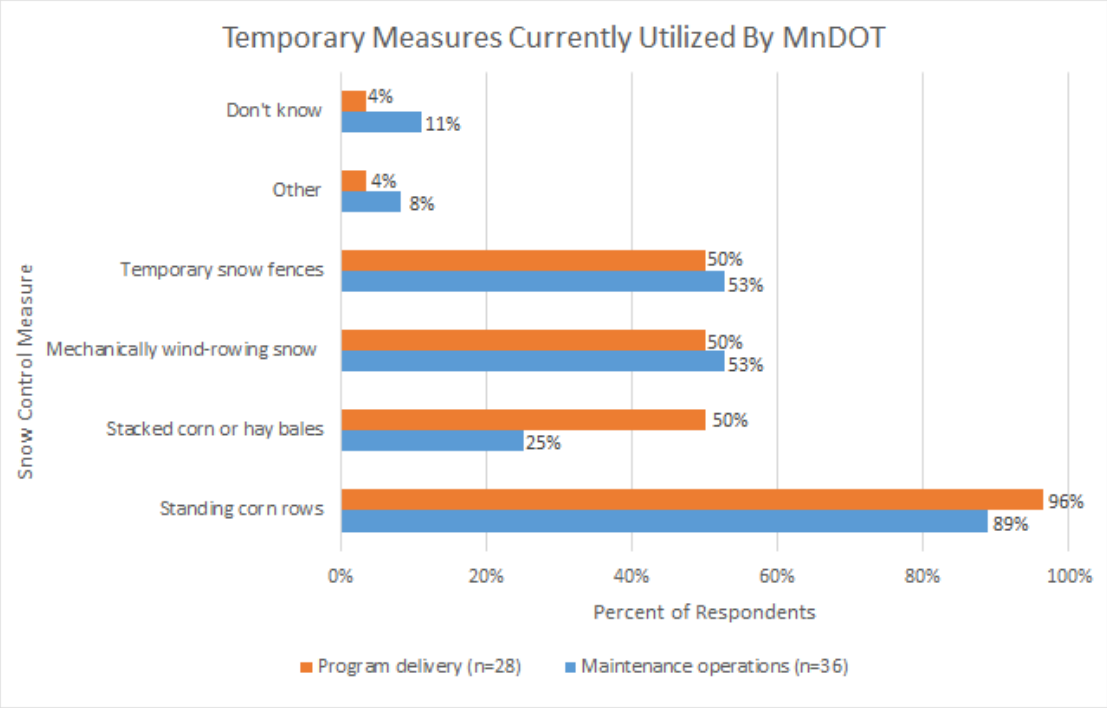


Figure 2.10 Knowledge of Temporary Measures Crosstabs

2.2.6 Q6: What are the current permanent blowing-snow-control options used by MnDOT?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.11 below.

Answer Choices	Responses
Living snow fences	**91%** 59
Structural snow fence (wood or flexible composite rail)	**40%** 26
Earthwork (raising the road grade or flattening the back slopes)	**62%** 40
Don't know	**11%** 7
Other (please specify)	**2%** 1
Total Respondents: 65	

Figure 2.11 Knowledge of Permanent Measures Descriptive Statistics

Most respondents (91%) report that living snow-fences are used for permanent snow-control. The second most commonly cited method of permanent snow-control was earthwork (62%) followed by structural snow fencing (40%). 11% of respondents reported that they did not know of any permanent snow-control options currently being utilized. One participant also mentioned that earthwork was a method used by MnDOT in the past. Figure 2.11 provides cross-tabulated data (job type x permanent snow-control measures currently utilized by MnDOT) and shows that while program delivery and maintenance operations staff have similar knowledge of earthwork, maintenance operations staff are slightly more aware of living snow-fences and significantly more aware of structural snow-fences compared to program delivery staff.

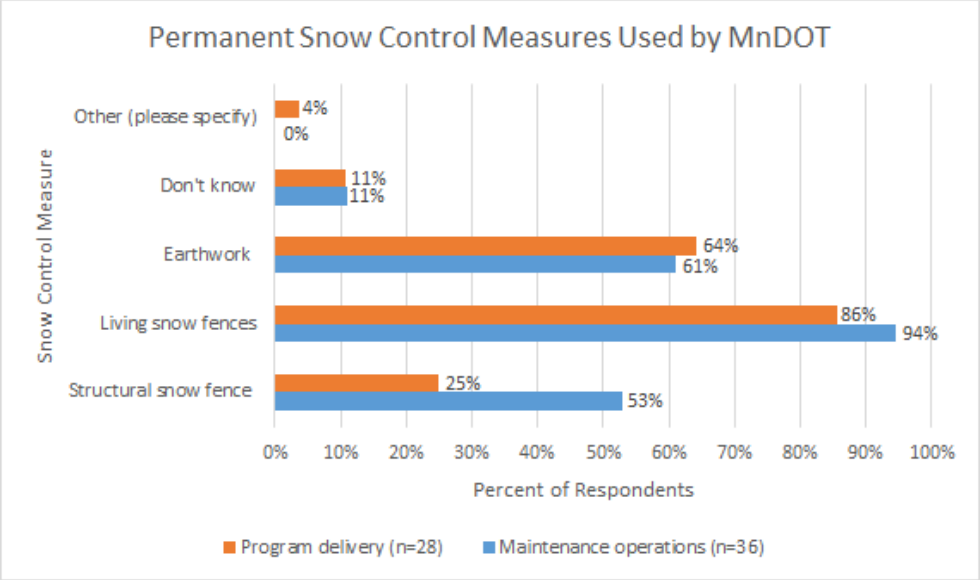


Figure 2.12 Knowledge of Permanent Measures Crosstabs

2.2.7 Q7: Please indicate your familiarity with the following blowing-snow-control practices.

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.13 below.

	A I have actually worked with landowners to implement this practice	B I have seen this practice but have not used it myself	C I am not aware of this practice	D Which of these practices worked well for you?	E Which of these practices were well received by the landowner?
Standing corn rows	**15%** 10	**80%** 52	**0%** 0	**2%** 1	**3%** 2
Stacked corn or hay bales	**9%** 6	**53%** 34	**33%** 21	**2%** 1	**3%** 2
Living snow-fences using hybrid willows	**6%** 4	**63%** 39	**29%** 18	**0%** 0	**2%** 1
Living snow-fences with traditional species ex. Dogwood	**11%** 7	**65%** 40	**21%** 13	**0%** 0	**3%** 2
Temporary snow-fences (4 foot tall orange fences)	**16%** 10	**70%** 43	**11%** 7	**3%** 2	**0%** 0
Permanent structural snow-fence	**6%** 4	**60%** 38	**30%** 19	**2%** 1	**2%** 1
Earthwork (raising the road grade or flattening back slope)	**17%** 11	**67%** 42	**10%** 6	**5%** 3	**2%** 1

Figure 2.13 Familiarity of Blowing-snow-control Practices Descriptive Statistics

Column A in Figure 2.13 shows that the majority of MnDOT employees have not actually worked with landowners to implement any of the listed practices. The most frequently indicated practice was earthwork (17%) followed by temporary snow-fences (16%) and standing cornrows (15%). Column B shows that the majority (between 53%-80%) of MnDOT employees have seen all the various listed practices, but have not used them personally. The most frequently selected practice in this question was standing corn rows (80%) followed by temporary snow-fences (70%), earthwork (67%) and living snow-fences using traditional species (65%) and hybrid willows (63%). Column C represents MnDOT employees' awareness of various practices. No more than a third (33%) of MnDOT employees indicated that they were *not* familiar with any of the practices listed. All respondents indicated that they are aware of standing cornrows, while only 66% indicated that they were aware of stacked corn or hay bales. Other less familiar practices included permanent structural snow-fences (with 30% indicating that they were not aware of the practice), living snow-fences using hybrid willows (29% not aware) and living snow-fences using traditional species (21% not aware). Columns D and E relate to the second part of the question: which of the listed practices worked well and which were well received by the landowners? Due to a formatting issue in Survey Monkey, respondents were not able to answer both the first part of the question (Columns A, B and C) and the second part (Columns D and E). Therefore, the second part of the question did not receive many responses. However, those responses are further analyzed in Figure 2.14 below.

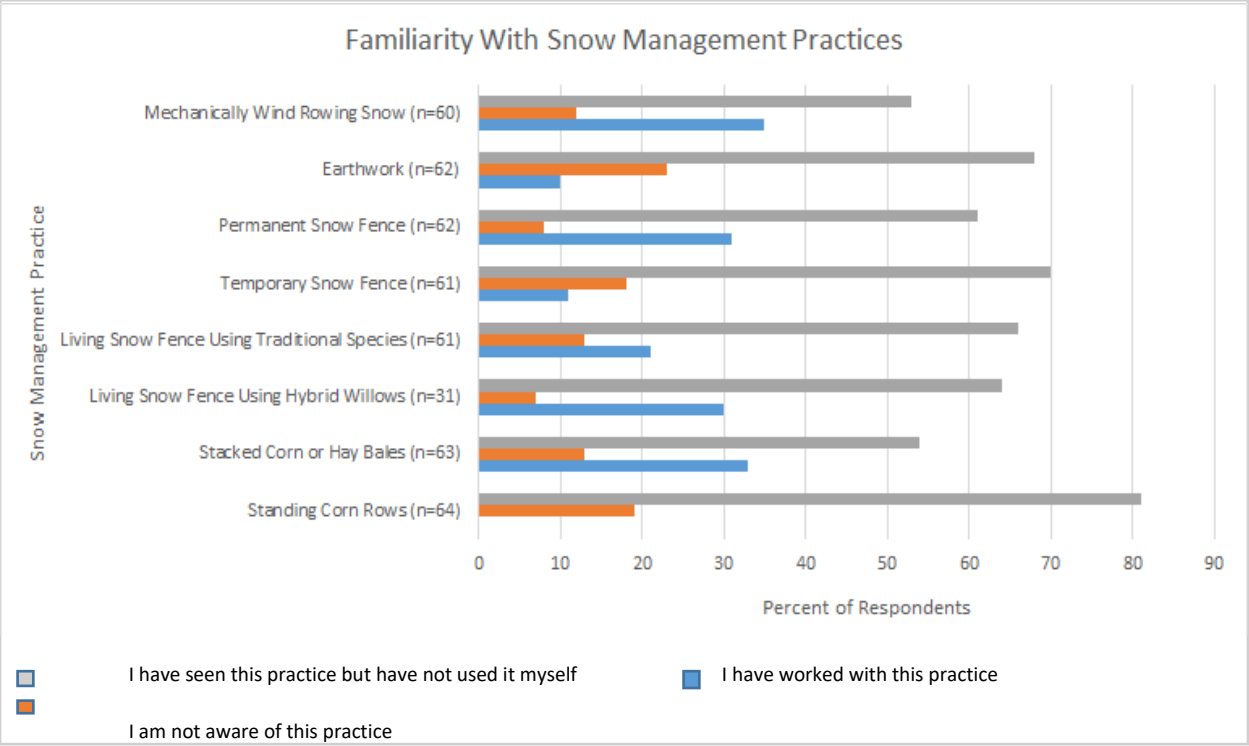


Figure 2.14 Familiarity of Blowing-snow-control Practices Crosstabs

Figure 2.14 shows that 100% of survey respondents either have seen (80%) or used (15%) standing cornrows. The most commonly used snow-fence practices include standing cornrows, temporary snow-fences (18%) and earthwork (23%). Survey respondents were most likely to be unaware of mechanically wind rowing snow (35%), permanent snow-fence (31%), living snow-fences using hybrid willows (30%) and stacked corn/hay bales (33%). In total, MnDOT employees were most likely to report that they have seen the different snow-control practices rather than having used them or not being aware of them.

Figure 2.15 provides a side-by-side comparison of maintenance operations and program delivery staff familiarity with different blowing-snow-control practices. The comparison shows that program delivery staff were less familiar with the blowing-snow-control practices compared to maintenance operations staff. Maintenance operations staff were more likely to report having used the different practices and program delivery staff were more likely to report that they were unaware of the different practices.

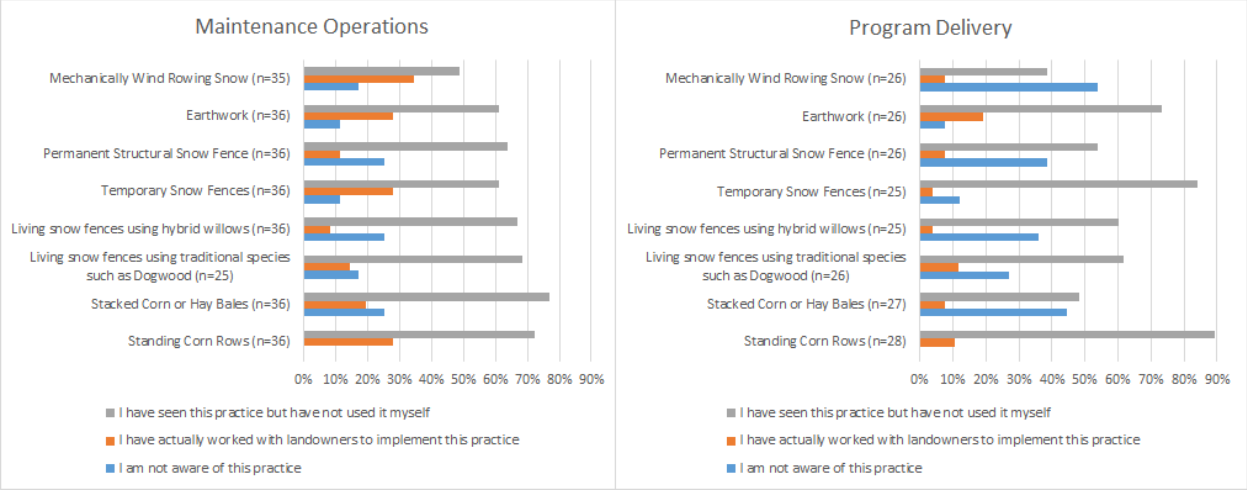


Figure 2.15 Familiarity of Blowing-snow-control Practices Side by Side Comparison

Question 7 also asked survey respondents with experience with snow-control practices to identify which snow-control practices worked well or were well received by the landowner. Those responses are indicated by columns D and E in Figure 2.13. While the response rate for the questions were low (*n=7*), the cross tabulated (job type x which of these practices were well received / worked well for you) results are shown in Figure 2.16 below. The most commonly cited practices were earthwork and standing cornrows. No respondents mentioned mechanically windrowing and only one respondent cited living snow-fences using hybrid willows. In addition, only program delivery staff mentioned earthwork, permanent structural snow-fences, and living snow-fences as practices that either were well-received by a landowner or worked well for you. Only maintenance operations staff identified temporary snow-fences.

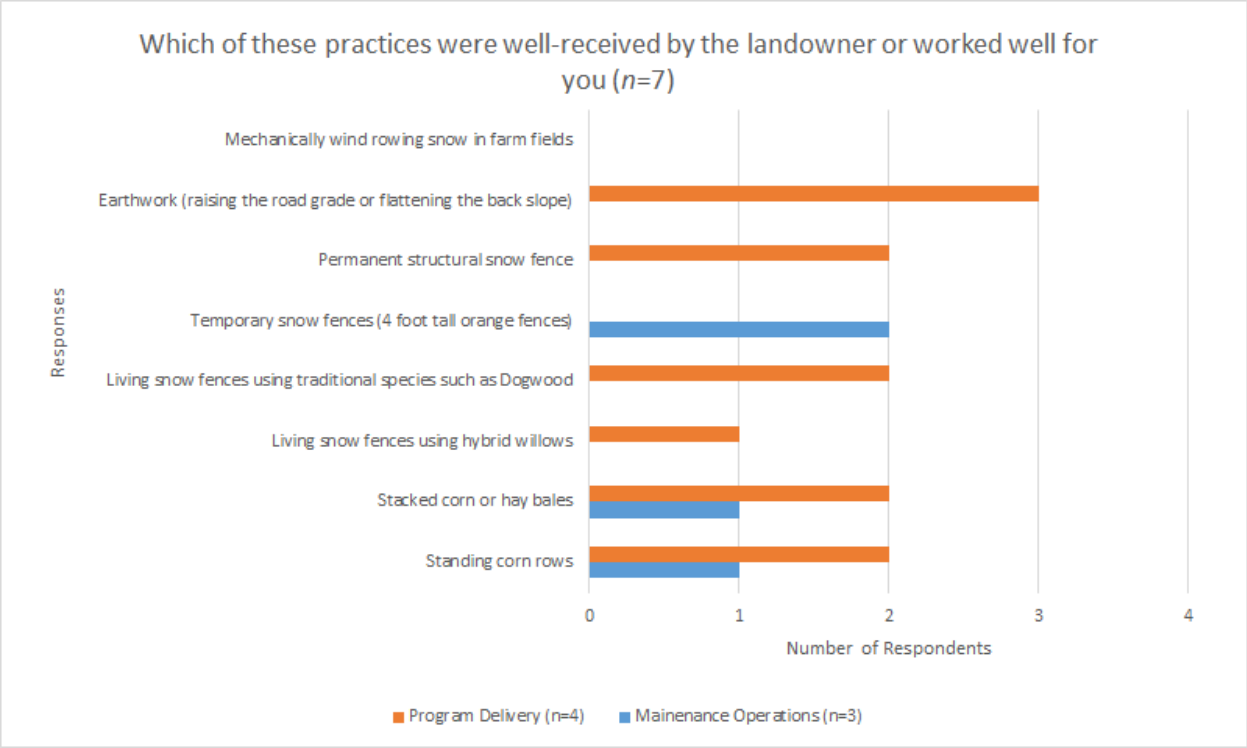


Figure 2.16 Practices Well-Received by Landowners Crosstabs

2.2.8 Q8: If a practice worked well for you, please describe where the practice was used.

36 individuals answered this question; 30 skipped it. Descriptive statistics are given in Figure 2.17 below.

Answer Choices	Responses
On my own land	17% 6
On one of my projects	47% 17
Other (please specify)	47% 17
Total Respondents: 36	

Figure 2.17 Where Practices Worked Well Descriptive Statistics

Figure 2.17 shows that survey respondents most often reported having success with blowing-snow-control practices on one of their projects (47%) or "other" (47%). About a third of the respondents that marked “other” on the survey reported that the question did not apply to them or that they did not own or work on land that is affected. Another third of respondents that marked “other” reported having seen blowing-snow-control practices on MnDOT roads or on their plow routes. For example, one participant

wrote, “Any type of snow-fence helps on our snow routes as I am a plow operator.” The final third of respondents that marked “other” reported that blowing-snow-control practices have worked well on private farm fields and in specific locations such as in high-wind areas West of the Twin Cities, on 12 West of Cokato, and on highway 68.

The cross-tabulated data in Figure 2.18 (job type x where blowing-snow-control practices have worked) shows that more program delivery staff reported that blowing-snow-control practices worked on a project and more maintenance operations staff selected “other” and identify a different or more specific location.

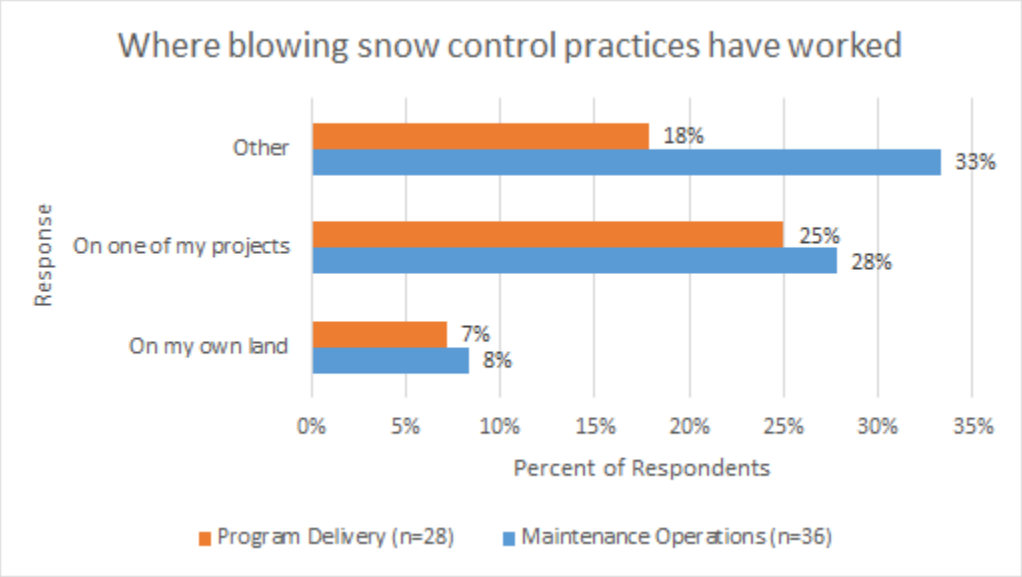


Figure 2.18 Where Practices Worked Well Crosstabs

2.2.9 Q9: Please indicate your level of familiarity with the following blowing-snow-control tools.

64 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 2.19 below.

	I have actually used this tool	I have seen this tool used but have not used it myself	I am not aware of this tool
Minnesota Winter Climate Design Tool	**6%** 4	**19%** 12	**75%** 48
Benefit cost tool	**3%** 2	**25%** 16	**71%** 45
Highway Development Process - Blowing and Drifting Snow Control	**3%** 2	**38%** 24	**59%** 37
Program procedures/forms	**5%** 3	**27%** 17	**68%** 43
District snow trap inventory	**6%** 4	**32%** 20	**62%** 39
MNDOT living snow fence website	**16%** 10	**41%** 26	**44%** 28
CTS snow control website	**8%** 5	**17%** 11	**75%** 48

Figure 2.19 Familiarity with Tools Descriptive Statistics

MnDOT has developed a suite of tools to assist employees in designing and implementing blowing-and-drifting snow-control measures. We asked staff about their knowledge and use of those tools. In Figure 2.19 above, the most frequently selected response for each tool is highlighted. For every tool listed, survey respondents most frequently indicated that they were "not aware of this tool". The most utilized tool was the MnDOT living snow-fence website (16%) and only a very small percentage of survey respondents (3%-8%) use the other tools. No more than 41% of survey respondents have even seen any of the tools. The tools that survey respondents are least aware of include the Minnesota Winter Climate Design Tool and the CTS Snow-control Website (75% each).

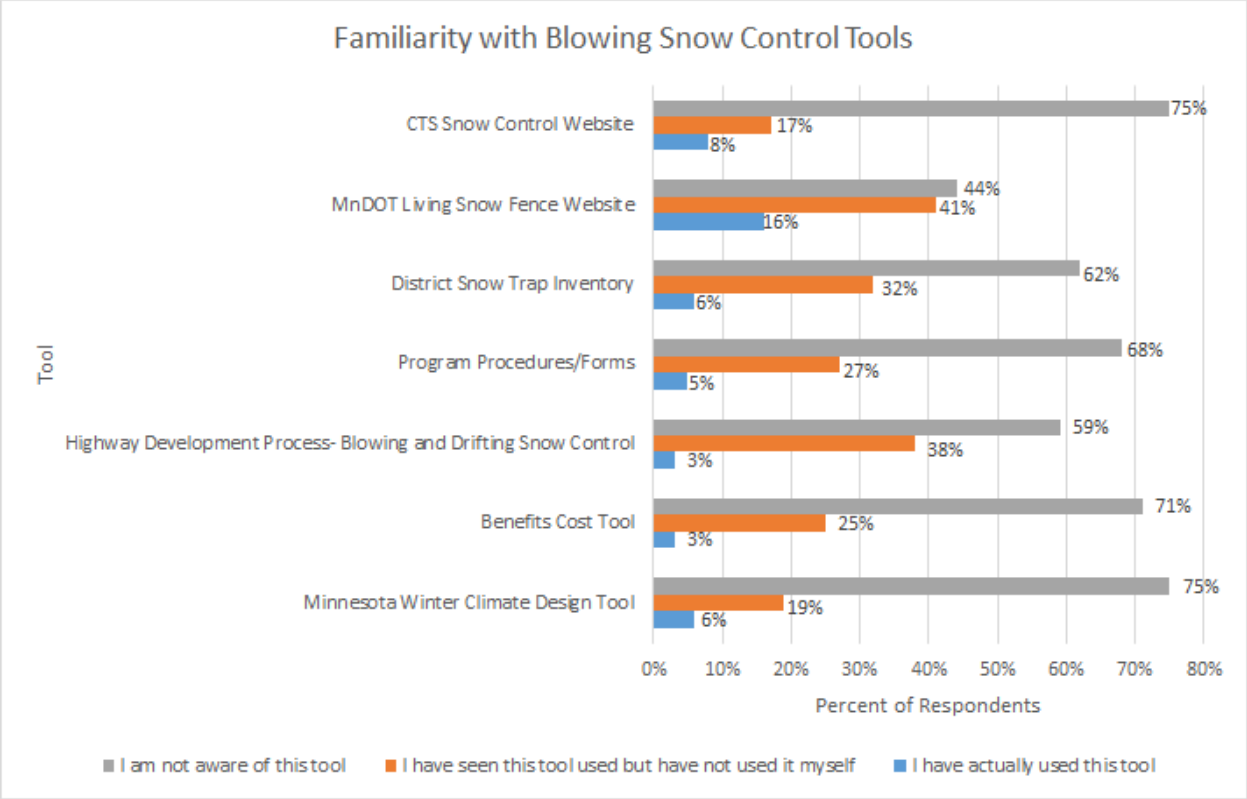


Figure 2.20 Familiarity with Tools Crosstabs

2.2.10 Q10: Who is your MnDOT District 8 living snow-fence coordinator?

38 individuals answered this open-ended question; 28 skipped it. Descriptive statistics are given in Figure 2.21 below.

Survey Responses	**Responses**
Craig Gertsma	33% (*n*=12)
Incorrect Guess	18% (*n*=7)
I don't know	49% (*n*=19)
Total Respondents: 38	

Figure 2.21 Knowledge of District 8 Snow-fence Coordinator Descriptive Statistics

Each MnDOT district has a designated living snow-fence coordinator. The coordinator for District 8 is Craig Gertsema. The statewide coordinator is Dan Gullickson. 33% of survey respondents were aware that the District 8 Living Snow-fence Coordinator is Craig Gertsema. The remaining 67%, either guessed incorrectly, could only identify the past living snow-fence coordinator or wrote that they did not know. A bar chart summarizing these results is included below in Figure 2.22.

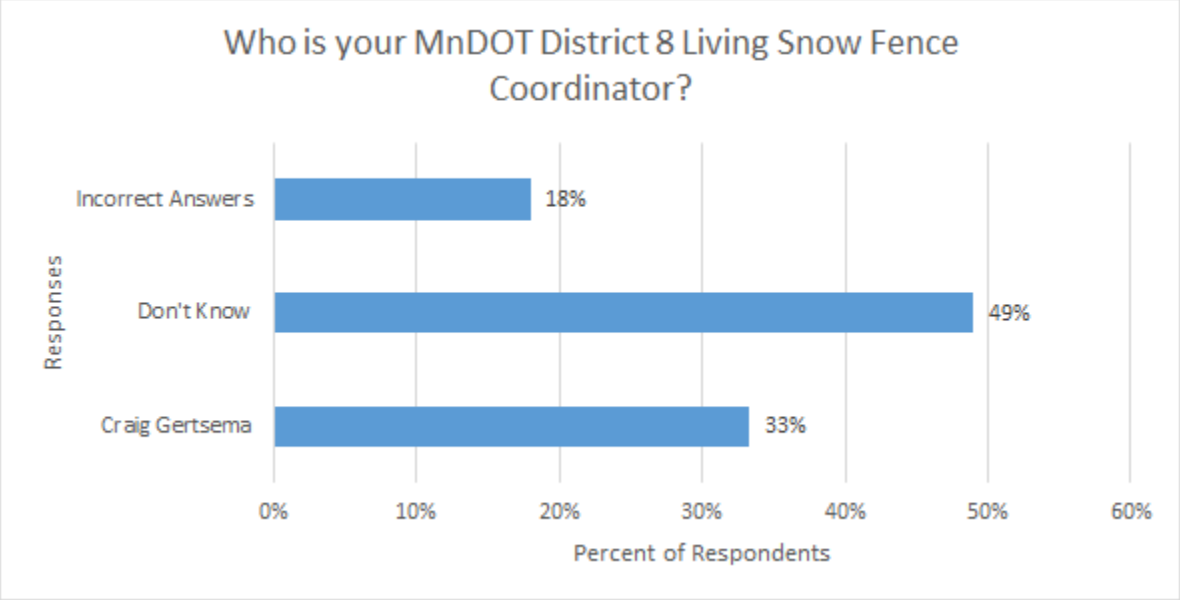


Figure 2.22 Knowledge of District 8 Snow-fence Coordinator Bar Chart

2.2.11 Q11: Who is the statewide snow-fence coordinator?

36 individuals answered this open-ended question; 30 skipped it. Descriptive statistics are given in Figure 2.23 below.

Survey Responses	Responses
Dan Gullickson	25% (*n*=9)
I don't know	75% (*n*=27)
Total Respondents: 36	

Figure 2.23 Knowledge of State Snow-fence Coordinator Descriptive Statistics

25% of survey respondents were aware that the statewide snow-fence coordinator was Dan Gullickson. The remaining 75% wrote that they did not know the name of the Statewide Snow-fence Coordinator. A bar chart summarizing these results is included below in Figure 2.24.

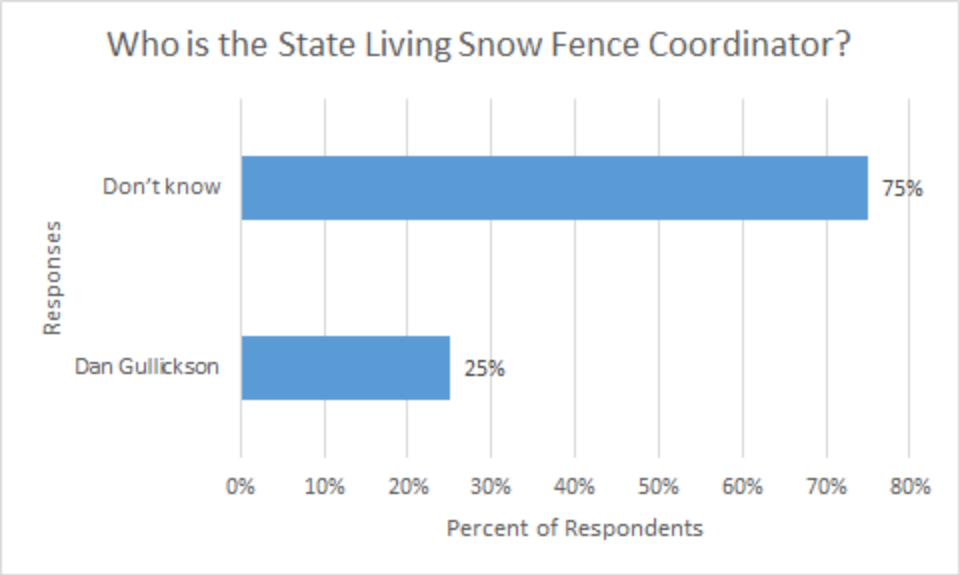


Figure 2.24 Knowledge of District 8 Snow-fence Coordinator Bar Chart

2.2.12 Q12: What are the best practices for implementing blowing-snow-control measures?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.25 below.

Answer Choices	Response
Target areas identified by snow plow operators as being problematic by referring to the snow trap inventory	**71%** 46
Design a solution using the winter climate website to determine the potential snow transport	**28%** 18
Assess the blowing snow control practice cost effectiveness using the benefit cost tool	**37%** 24
Ensure that measures are acceptable to the adjacent landowner	**57%** 37
Don't know	**23%** 15
Other (please specify)	**3%** 2
Total Respondents: 65	

Figure 2.25 Best Practices Descriptive Statistics

71% of survey respondents identified targeting areas identified by snowplow operators as being problematic by referring to the snow trap inventory as being a best practice. The second most popular best practice (57%) was to ensure that measures are acceptable to the adjacent landowner. 23% of survey respondents also reported that they do not know any best practices. Other best practices that were

suggested included updating the existing inventory using all wind direction areas and not just North wind problem areas. Another respondent said that everything seems to be under control and nothing more is needed.

The cross-tabulated data in Figure 2.26 (job type x best practices) shows that program delivery and maintenance operations staff have similar ideas about best practices, but maintenance operations staff are more likely to identify ensuring that measures are acceptable to the adjacent landowner as well as designing solutions using winter climate website as best practices. Program delivery staff were more likely to identify targeting areas identified by snow operators and assessing the cost effectiveness of blowing-snow-control practices.

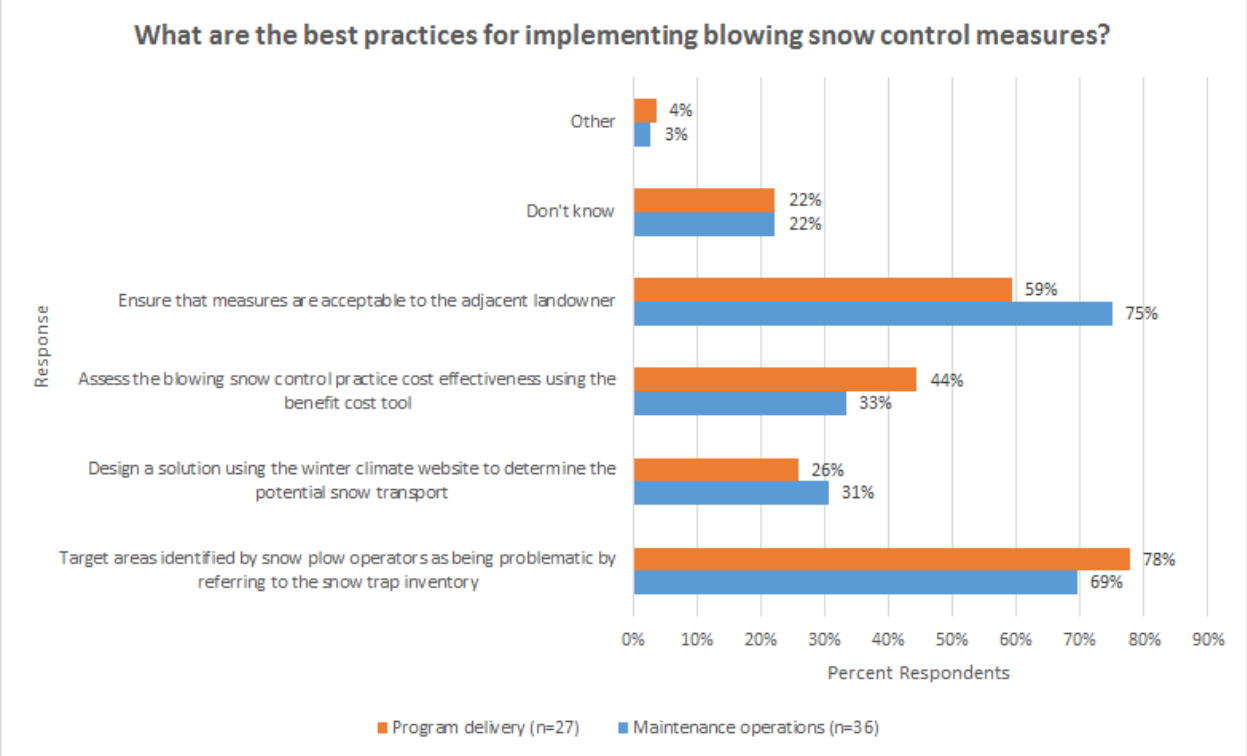


Figure 2.26 Best Practices Crosstabs

2.2.13 Q13: In your experience, is there a difference in willingness to adopt a temporary snow-control measure between landowners and renters?

64 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 2.27 below.

Answer Choices	Responses
Yes (please describe in the space below)	**9%** 6
No	**9%** 6
Don't know	**77%** 49
Other (please specify)	**5%** 3
Total	**64**

Figure 2.27 Willingness to Adopt Temporary Snow-control Descriptive Statistics

Most survey respondents (77%) reported that they do not know if there is a difference in the willingness to adopt temporary snow-control measures between landowners and renters. While Figure 2.27 shows that the same number of respondents (9%) said "yes" and "no" to the questions, the cross-tabulation in Figure 2.28 (job type x willingness to adopt temporary snow-control) shows that only maintenance operations staff answered "yes" to this question. Figure 2.28 shows that program delivery staff were more likely to not know if there is a difference between landowner and renter willingness to adopt temporary snow-control measures compared to staff involved in maintenance operations.

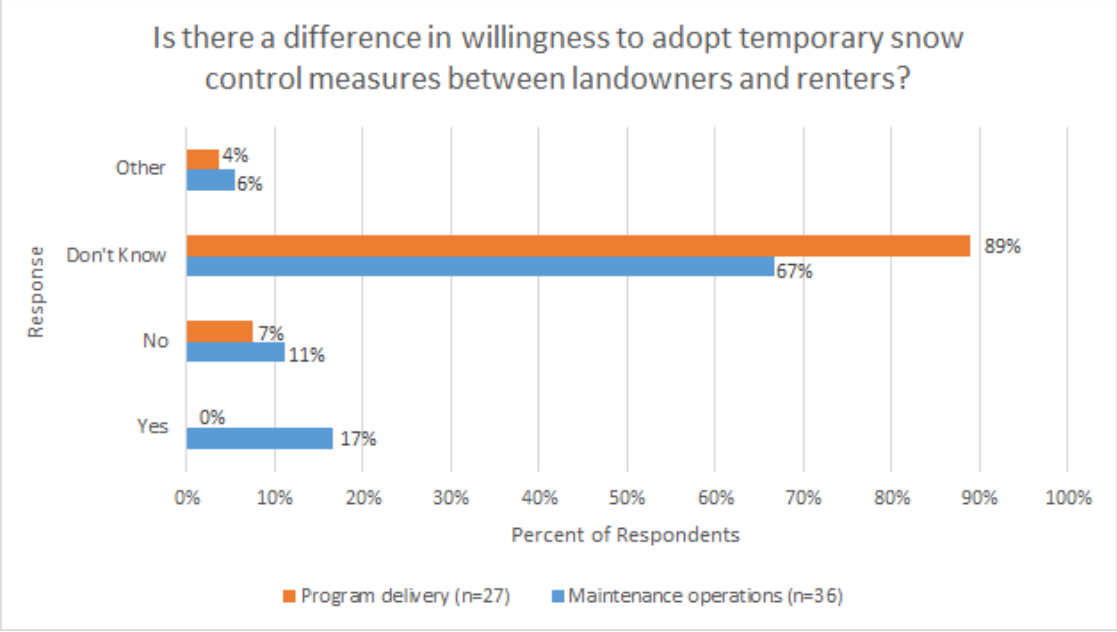


Figure 2.28 Willingness to Adopt Temporary Snow-control Crosstabs

2.2.14 Q14: In your experience, is there a difference in willingness to adopt a permanent snow-control measure between landowners and renters?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.29 below.

Answer Choices	Responses
Yes (please describe in the space below)	9% 6
No	9% 6
Don't know	75% 49
Other (please specify)	6% 4
Total	65

Figure 2.29 Willingness to Adopt Permanent Snow-control Descriptive Statistics

Most survey respondents (75%) reported that they do not know if there is a difference in the willingness to adopt permanent snow-control measures between landowners and renters. A small percentage (6%) of respondents also chose "other." These respondents pointed out that renters typically want a break in $/acre, but the landowner typically ultimately makes the decision to install permanent fencing. In addition, respondents pointed out that permanent structures need to be farmed around (and farmers typically do not want to farm around trees or permanent structures) while temporary fences require extra work in the spring to harvest or remove. While Figure 2.29 shows that the same number of respondents (9%) said "yes" and "no" to the questions, the cross-tabulation in figure 2.30 (job type x willingness to adopt permanent snow-control) shows that only maintenance operations staff answered "yes" to this question. In addition, Figure 2.30 shows that MnDOT staff involved in program delivery were significantly more likely to not know if there is a difference between landowner and renter willingness to adopt permanent snow-control measures compared to staff involved in maintenance operations. MnDOT maintenance staff were equally likely to respond both "yes" and "no" to this question.

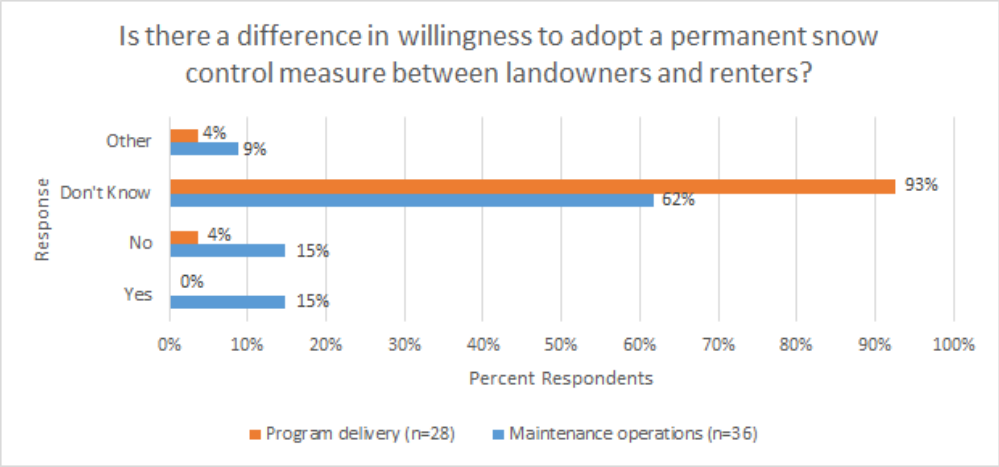


Figure 2.30 Willingness to Adopt Permanent Snow-control Crosstabs

2.2.15 Q15: In your experience, are landowners happy with the existing blowing-snow-control program?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.31 below.

Answer Choices	Responses
Yes	**11%** 7
No	**6%** 4
Don't know	**77%** 50
Other (please specify)	**6%** 4
Total	**65**

Figure 2.31 Landowner Satisfaction with Snow-control Descriptive Statistics

Most survey respondents (77%) reported that they do not know the answer to this question. The second most popular answer (11%) was "Yes" and one participant commented that he/she has only heard positive comments from landowners. The respondents that chose "other" pointed out that landowner satisfaction depends on several factors including the farmer's mentality (community service vs. income maximization) as well as the weather during a year. For example, cold springs and late snowmelts can affect soil temperatures for spring planting. The cross-tabulated data (job type x landowner happiness) in Figure 2.32 reveals that 96% of program delivery staff reported that they "don't know" the answer to this question. The only respondents that answered "yes" or offered additional comments were maintenance operations staff.

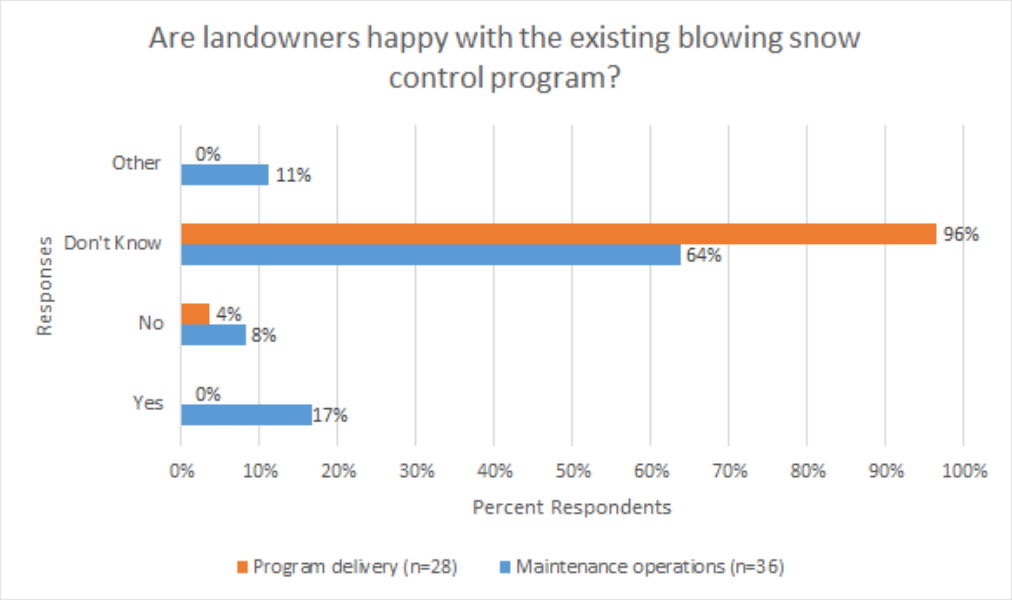


Figure 2.32 Landowner Satisfaction with Snow-control Crosstabs

2.2.16 Q16: What do you think prevents farmers from signing up in MnDOT's blowing-snow-control program?

65 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 2.33 below.

Answer Choices	Responses
They are renters	**35%** 23
Lack of awareness about the program	**58%** 38
Lack of time	**6%** 4
Lack of interest	**38%** 25
Lack of trust in a government agency	**37%** 24
Lack of familiarity with MNDOT bureaucratic procedures	**42%** 27
They may be farming in the MNDOT right of way	**43%** 28
Don't know	**25%** 16
Other (please specify)	**15%** 10
Total Respondents: 65	

Figure 2.33 Landowner Deterrents Descriptive Statistics

According to survey respondents, the most commonly cited factor as preventing landowner participation in the snow-control program was lack of awareness about the program (58%). Other commonly cited factors included lack of familiarity with MnDOT bureaucratic procedures (42%) and farming in the MnDOT right of way (43%). The least cited factors included lack of time (6%) or other (15%). Respondents that marked "other" also described several additional deterrents to participation including landowner inconvenience, insufficient incentives, and issues related to taxes, insurance and liability. Some landowners do not want the extra snow building up in their fields because it can cause moisture buildup in the spring, inconveniencing planting. In addition, removing standing corn can be a hassle in the spring. The size of typical farming equipment also makes it difficult to work around snow-fences. Landowner compensation for loss of productive acres also comes into play as a deterrent to participation. For some the incentive offered is not sufficient, as farmers require financial reimbursement for any use of their land. Snow-control may also be another thing to worry about for farmers. One participant also commented that the problem is not as bad as people think[1].

[1] It is important to note that these results do not directly show landowner opinions but rather MnDOT employee perceptions of landowner opinions. More research directly involving landowners would be necessary to make inferences about landowner opinions or perceptions.

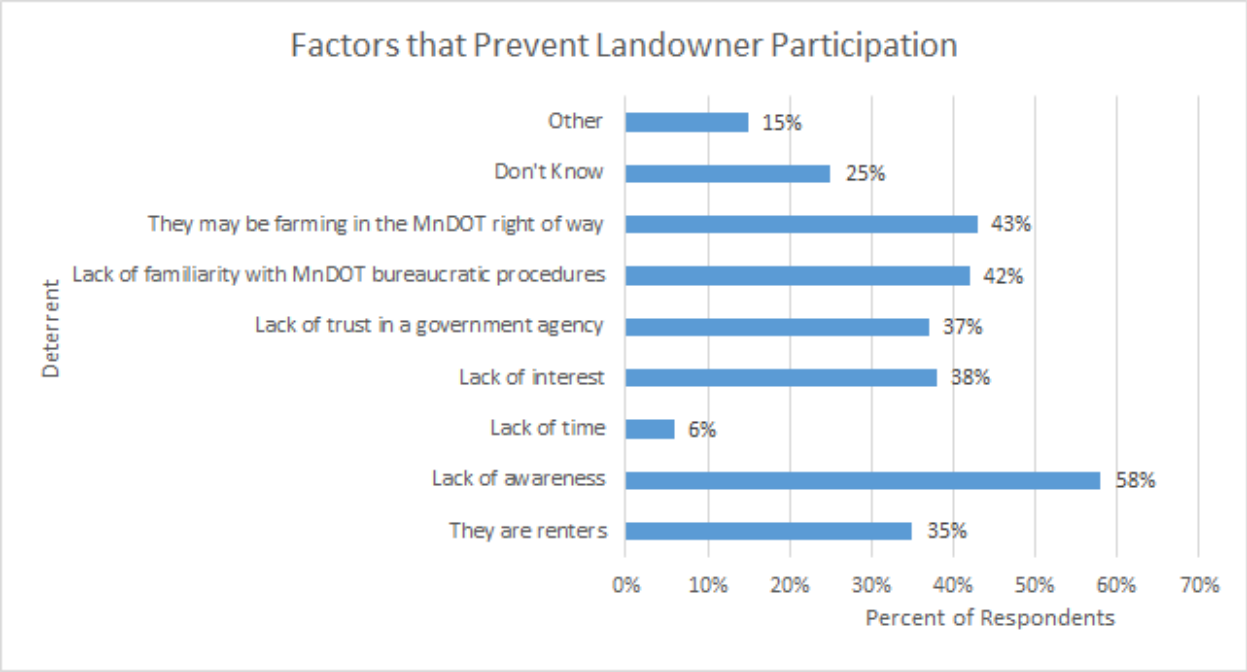


Figure 2.34 Landowner Deterrents Bar Chart

2.2.17 Q17: How should we obtain landowner interest in adopting temporary or permanent blowing-snow-control measures?

65 individuals answered this question, while one skipped it. Descriptive statistics are presented in Figure 2.35 below.

Answer Choices	Responses
Incentives	**52%** 34
Easements	**22%** 14
Being involved in the decision-making process	**42%** 27
Educational outreach to local landowners on blowing snow measures	**62%** 40
Signage recognizing the landowner as a program participant	**37%** 24
Other public recognition in a local newspaper	**38%** 25
Don't know	**17%** 11
Other (please specify)	**8%** 5
Total Respondents: 65	

Figure 2.35 How to Obtain Landowner Interest Descriptive Statistics

Most respondents (62%) indicated that MnDOT should provide educational outreach to landowners in blowing-snow-control measures. 52% thought that incentives should be given to increase landowner interest and 42% of individuals reported that landowners should be involved in the decision-making process. Respondents also indicated that recognition, either in the form of signage recognizing the landowner as a participant (37%) or other public recognition in a local newspaper (38%) should be used to increase landowner interest. An additional 17% of individuals responded with "don't know" and another 8% indicated "other". Other suggestions included building trust, promoting awareness of problem areas to landowners and renters to promote existing incentives, and sending a survey out to landowners. One participant also suggested expanding the program from the scale of the county to the level of the state. Another participant seemed to suggest that retracting new policy requiring buffers around state waterways would also increase landowner interest.

In addition, this data illustrates that there may be other methods of obtaining landowner interest aside from the typical methods that MnDOT is currently using. While incentives and easements are typical tools utilized by MnDOT to encourage landowner engagement, there may be other means of incentivizing participation that are not captured in this survey. For example, results from both question 16 and 17 indicate that survey respondents believe that promoting awareness of the program would result in more landowner participation. However, it is also important to note that this information is a secondary perception and does not directly reflect landowner opinions. More research needs to be performed involving local landowners and their incentives for participating in MnDOT's living snow-fence program. The question of landowner opinions is a topic that should be further explored through more direct work with landowners. MnDOT should not use this data to make decisions based on landowner opinions.

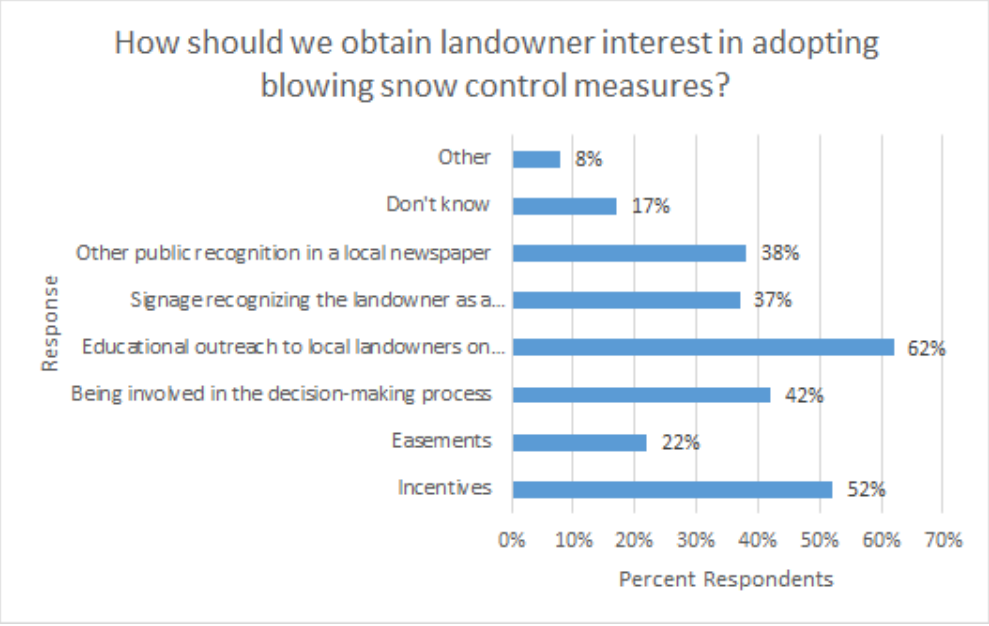


Figure 2.36 How to Obtain Landowner Interest Bar Chart

2.2.18 Q18: Have you talked with local residents about blowing-snow?

64 individuals answered this question; two skipped it. Descriptive statistics are presented in Figure 2.37.

Answer Choices	Response
Yes	19% 12
No	67% 43
If yes, what observations have they made about blowing snow? Please comment in the space below.	2% 1
Other (please specify)	13% 8
Total	**64**

Figure 2.37 Landowner Interaction Descriptive Statistics

Most respondents (67%) indicated they have not talked with residents about blowing-snow. 19% said that they have communicated with local residents and another 13% of respondents selected "other". Most of the respondents that selected "other" included comments about conversations with local residents about blowing-snow. If those describing interactions with landowners while selecting "Other" are considered respondents in the "Yes" category as well, a total of 31% of respondents indicated that they have talked with local residents. A couple of the respondents leaving comments mentioned that landowners are concerned about the extra hassle and time that snow-fences require. As the cross-tabulated data (job type x communication with local residents) in Figure 2.38 below shows, only maintenance operations staff reported having talked with local community members about snow-fences. The data presented in this Figure reflects data shown in previous questions where program delivery staff most commonly reported that they "don't know" when asked questions about landowner perceptions. The likelihood of Program delivery staff to report that they do not know about landowner perceptions is likely due to the lack of direct communication between program delivery staff and local residents.

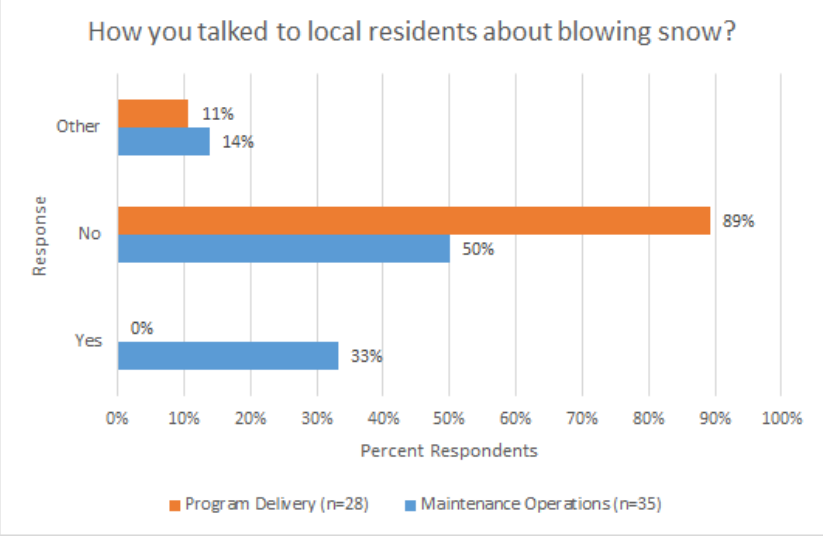


Figure 2.38 Landowner Interaction Crosstabs

2.2.19 Q19: What prevents you from implementing snow-control measures?

62 individuals answered this question; two skipped it. Descriptive statistics are presented in Figure 2.39.

Answer Choices	Responses
Lack of time and compensation to work on snow control measures	16% 10
Lack of knowledge	18% 11
Lack of training	15% 9
Lack of funding	15% 9
Extensive permit/environmental review documentation that could delay the project	3% 2
Lack of available highway right of way	6% 4
Not a priority	16% 10
Don't know	40% 25
Other (please specify)	18% 11
Total Respondents: 62	

Figure 2.39 Barriers to Implementation Descriptive Statistics

Of the 62 individuals responding to this question, 25 of them (40%) indicated that they do not know what prevents them from implementing snow-control measures. Of the others, 18% indicated that the largest barrier was lack of knowledge, followed by "not a priority" (16%) and lack of time and compensation for work (16%), lack of training (15%) and lack of funding (15%), lack of available highway right of way (6%) and finally the extensive permit and review documentation that could delay the project (3%).

11 individuals (18%) also selected "other", writing in their own answers. Five of those indicating "other" noted that this was not applicable to their job or their location. One respondent also explained, "I am not a landowner, only a MnDOT employee that plows. Another respondent suggested that areas for blowing-snow-control should be identified during the preliminary design stage or a road project and funds should be dedicated for additional right-of-way. Finally, respondents provided additional comments on the lack of funding and time to visit with farmers and/or implement blowing-snow-control measures. According to the cross-tabulated data shown in Figure 2.40 maintenance operations staff were more likely to list time/compensation, knowledge, training and funding as barriers to implementation. Program delivery staff were more likely to report that they "don't know" or "other."

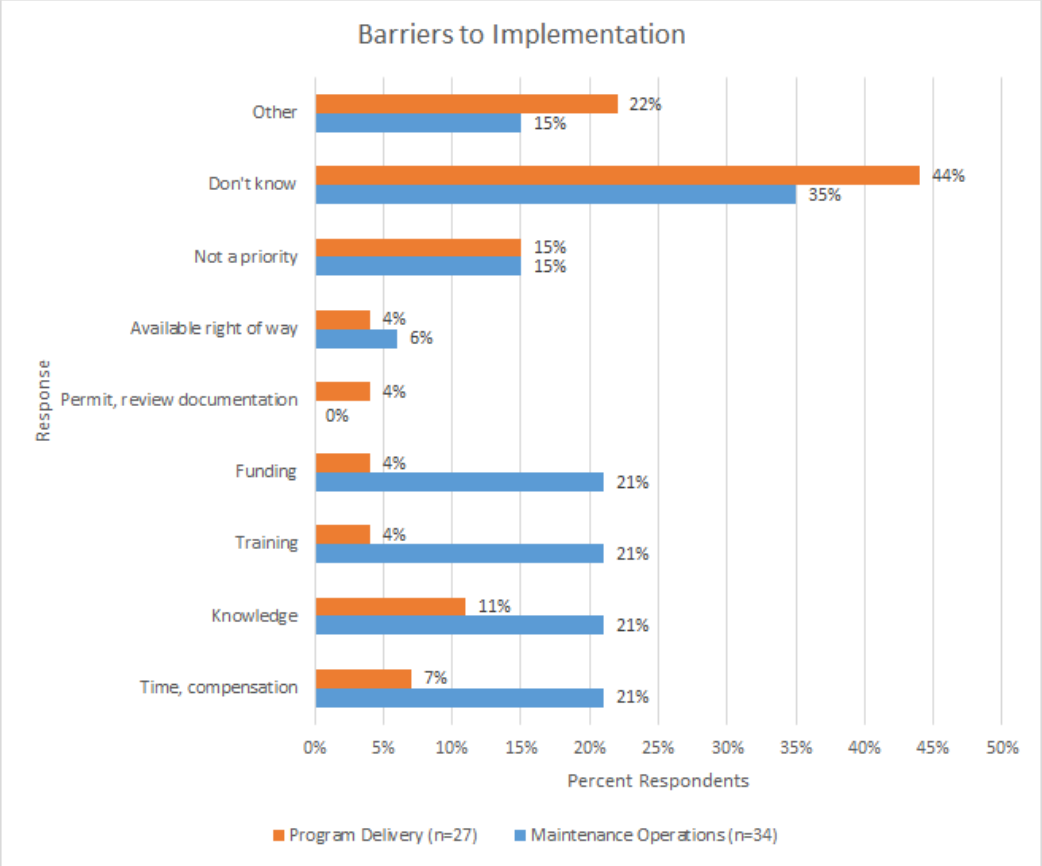


Figure 2.40 Barriers to Implementation Crosstabs

2.2.20 Q20: What would help you to implement snow-control measures?

62 individuals responded to this question, four skipped it. Descriptive statistics are in Figure 2.41.

Answer Choices	Responses
Opportunity for overtime and compensation for extra hours worked	**10%** 6
Training in communication with landowners	**26%** 16
Training about the program and incentives	**31%** 19
Training about the technical aspects of snow control measures	**32%** 20
Recognition	**10%** 6
Don't know	**44%** 27
Other (please specify)	**11%** 7
Total Respondents: 62	

Figure 2.41 Implementation Facilitators Descriptive Statistics

Of the 62 individuals responding to this question, 44% of them indicated that they "don't know" what would help them to implement snow-control measures. 32% responded that technical training would help, followed by training about the program and incentives (31%), training in communication with landowners (26%), opportunities for overtime and compensation for additional hours worked (10%) and recognition (10%). Additionally, seven individuals (11%) checked "other", either indicating that the question is not applicable to them, or providing a different suggestion. Additional suggestions included convincing landowners to participate, having more people that are familiar with the program and willing to reach out to farmers, and having time to start visiting with farmers earlier in the fall. Based upon these results it seems that training opportunities may remove constraints to implementation more effectively than increased funding for overtime.

The cross-tabulation in Figure 2.42 (job type x what would help you implement snow-control measures?) shows that maintenance operations staff are much more likely to report that program/incentives training and communication training would help them implement snow-control measures while program delivery staff were more likely to report that technical training and recognition are important.

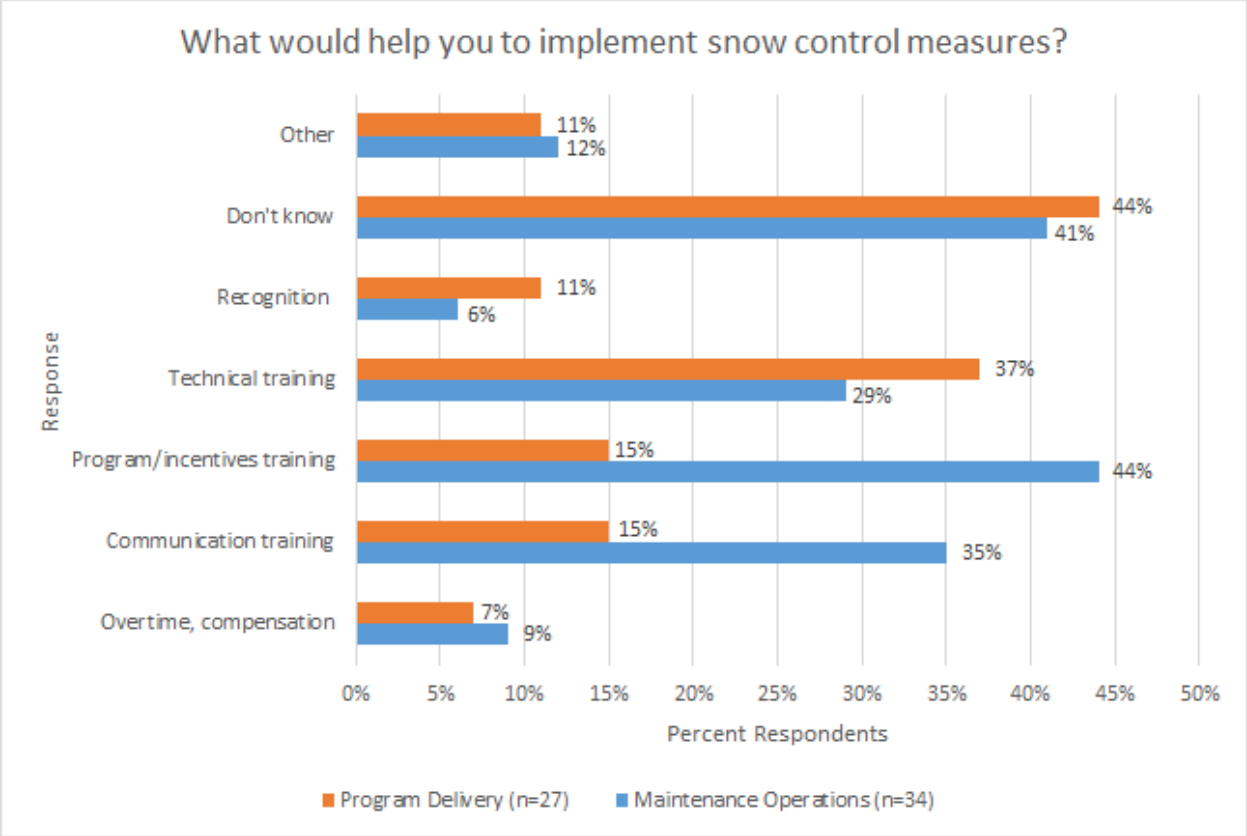


Figure 2.42 Implementation Facilitators Crosstabs

2.2.21 Q21: Do you think that landowners are concerned about blowing-snow?

64 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 2.43 below.

Answer Choices	Responses
Yes	**52%** 33
No	**17%** 11
Don't know	**23%** 15
Other (please specify)	**8%** 5
Total	**64**

Figure 2.43 Landowner Concern with Blowing-snow-control Descriptive Statistics

Over half (55%) of respondents indicated that landowners are concerned about blowing-snow, while 17% reported that they are not concerned and 23% reported that they do not know. Of those indicating "other" (8%), two of them mentioned soil erosion as a concern for landowners. Another indicated that landowners are only concerned "when it directly affects them". The cross-tabulation in Figure 2.44 (job type x are landowners concerned about blowing-snow) shows that there is not much difference in opinion between program delivery and maintenance operations staff.

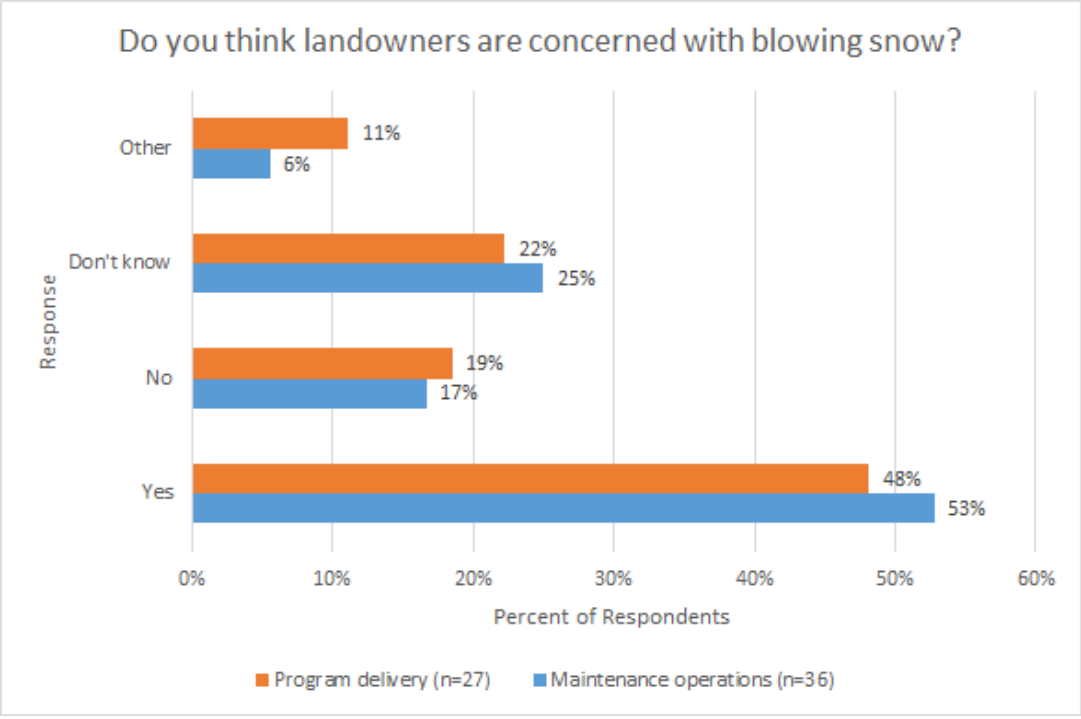


Figure 2.44 Landowner Concern with Blowing-snow-control Crosstabs

2.2.22 Q22: Do you think that landowners see benefits from blowing-snow-control?

64 individuals responded to this question; two skipped it. Descriptive statistics are given in Figure 2.45.

Answer Choices	Responses
Yes	55% 35
No	14% 9
Don't know	25% 16
Other (please specify)	6% 4
Total	64

Figure 2.45 Landowners Recognize Blowing-snow-control Descriptive Statistics

Over half (55%) of individuals reported that yes, they do believe that landowners see benefits from blowing-snow-control. 25% indicated that they do not know and 9 (14%) indicated that no, landowners do not see benefits from blowing-snow-control. Of the four individuals selecting "other", two of them specified that it varies. Some landowners see benefits, and some do not. The cross-tabulation (job type x do landowners see benefits from blowing-snow-control) shown in Figure 2.46 shows that more maintenance operations staff answered "yes" to this question while more program delivery staff answered "no."

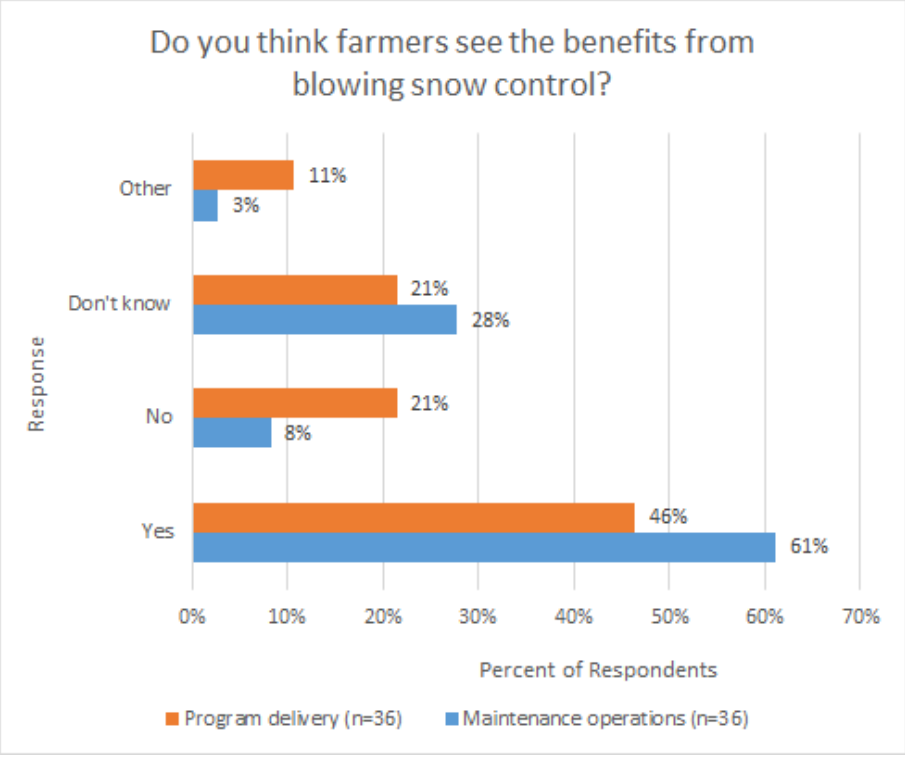


Figure 2.46 Landowners Recognize Blowing-snow-control Crosstabs

2.2.23 Q23: What do MnDOT employees need to know so they can better communicate with landowners about blowing-snow-control?

64 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 2.47 below.

Answer Choices	Response
Communication skills	36% 23
Conflict management skills	27% 17
Knowledge about blowing snow control measures (technical aspects)	55% 35
Costs/benefits of blowing snow control	61% 39
A greater understanding of MNDOT's blowing snow control process and standard operating procedures	59% 38
Don't know	20% 13
Other (please specify)	3% 2
Total Respondents: 64	

Figure 2.47 MnDOT Communication Needs Descriptive Statistics

Of the 64 individuals responding to this question, 61% reported that knowing the costs and benefits of blowing-snow-control would help them communicate with landowners. The second-most frequent response (59%) was that a greater understanding of MnDOT's blowing-snow-control process and standard operating procedures would be helpful, followed by knowledge about the technical aspects of various measures (55%), communication skills (36%) and conflict management skills (27%). Additionally, 13 individuals (20%) reported that they do not know what employees need to know to better communicate with landowners about blowing-snow-control. One of the comments specified in the other category stated that "nothing more is needed". The other respondent suggested having one or two staff in-charge of developing relationships with farmers to "sell" opportunities for blowing-snow-control on their land.

The cross-tabulation in Figure 2.48 (job type x what employees need to know to better communicate with landowners) shows that maintenance operations staff were more likely to write that they do not know what MnDOT staff need to know to effectively communicate with landowners. In addition, maintenance staff were more likely to report site communication skills and MnDOT process and SOP as important. Program delivery staff were more likely to say that cost/benefits, technical knowledge and conflict management skills are necessary.

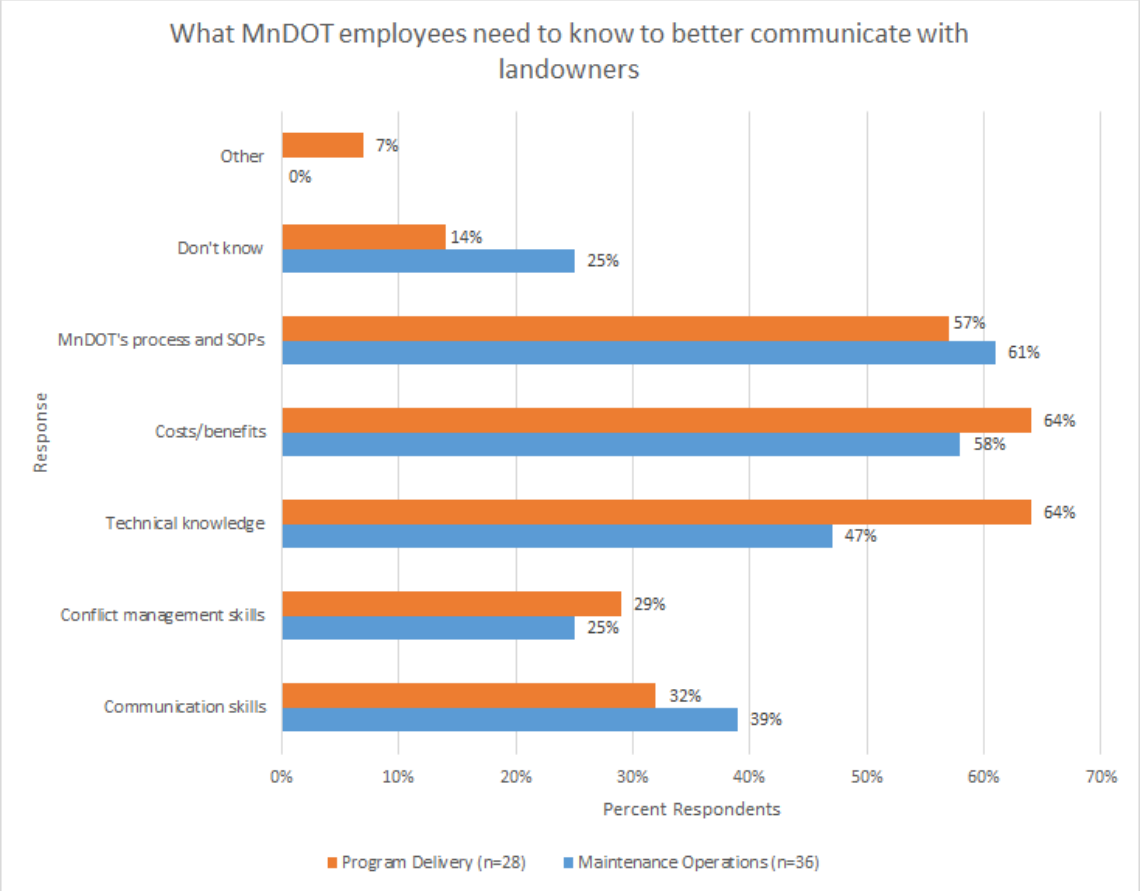


Figure 2.48 MnDOT Communication Needs Crosstabs

2.2.24 Q24: Are you willing to interact with landowners about blowing-snow-control?

62 individuals answered this question; four skipped it. Descriptive statistics are given in Figure 2.49 below.

Answer Choices	Responses
Yes	**37%** 23
Somewhat	**19%** 12
No	**8%** 5
Doesn't apply to me	**35%** 22
Other (please specify)	**0%** 0
Total	**62**

Figure 2.49 MnDOT Willingness to Interact with Landowners Descriptive Statistics

Among all respondents, 37% reported that yes, they are willing to interact with landowners about blowing-snow-control. The second-most frequent response was that the question did not apply to the respondent, with 22 individuals (35%) selecting this response. 19% responded that they were somewhat willing and 8% responded that no, they were not willing to interact with landowners about blowing-snow-control.

The cross-tabulation in Figure 2.50 (job type x willingness to interact with landowners) shows that program delivery staff were most likely to report that this question does not does not apply to them or that they are unwilling to interact with landowners. Maintenance operations staff were more likely to respond that they would be willing or somewhat willing to interact with landowners.

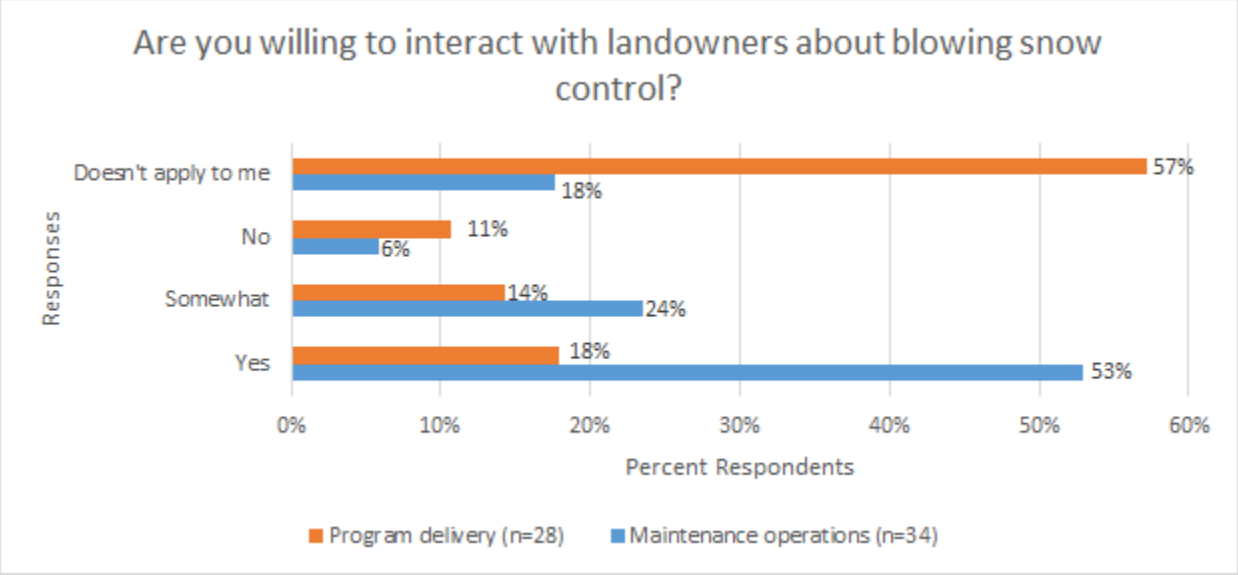


Figure 2.50 MnDOT Willingness to Interact with Landowners Crosstabs

This probably reflects job responsibilities, as they exist as well as employees' perceptions of their job responsibilities. In general, maintenance staff are the ones called upon to approach landowners and promote blowing-and-drifting snow-control. Program delivery staff work with engineering and planning roadway construction and would interact with landowners only if the blowing-and-drifting snow-control measures were part of a design that required placing a control measure on the land outside of the MnDOT right of way.

2.2.25 Q25: What would help you to more effectively recruit landowners to adopt blowing-snow-control measures?

25 individuals (28%) answered this question; 41 skipped it. Descriptive statistics are given in Figure 2.51 below.

Survey Responses	Responses
Don't know	8% (*n=2)*
This question does not apply to me	21% (*n=5)*
More knowledge/training	21% (*n=5)*
More resources (time, employees etc.)	25% (*n=6)*
Communication with landowners	21% (*n=5)*
Other	4% (*n=1)*
Total Respondents: 25	

Figure 2.51 What would help Recruit Landowners Descriptive Statistics

This was an open-ended question asking respondents to fill in answers. About 29% of respondents reported either that they do not know or that they do not work with the public and therefore the question does not apply to them. The next most common responses involved either more understanding/knowledge or more resources. Survey respondents often reported that trainings and knowing more about the blowing-snow-control program and blowing-snow-control measures would help them more effectively recruit landowners. In addition, more resources such as time and funding to reach out to landowners or even an additional employee to focus upon outreach would help. Several respondents pointed out that being able to talk individually with landowners about the program, answer their questions and demonstrate the cost savings involved would be helpful. Having more time to talk with farmers earlier in the season would also allow farmers to plan for the seasonal snow-fence program. Other suggestions included involving county and township roads in the program and holding informational public meetings with partners and interested landowners. Finally, survey respondents pointed out that it is necessary to talk with landowners when they are interested in the program and that sometimes landowners are reluctant to participate due to springtime cleanup.

2.2.26 Q26: Can you suggest any opportunities for public outreach and knowledge sharing on blowing-snow-control?

19 individuals (29%) answered this question; 47 skipped it. Descriptive statistics are given in Figure 2.52

Survey Responses	Responses
Mass Communication	44% (*n=8)*
On-location presentations	33% (*n=6)*
Don't know	6% (*n=1)*
Does not apply to me	11% (*n=2)*
Other	11% (*n=2)*
Total Respondents: 19	

Figure 2.52 Opportunities for Public Outreach Descriptive Statistics

Most commonly (44% of comments), respondents suggested using mass communication in the form of written bulletins, online information or radioed advertisements for public outreach. Suggested mass outreach techniques included bulletins, putting fliers in property tax statement saying that land qualifies for a blowing-snow-control project, advertising in local newspapers, and mailings. Online forms of outreach could include social media, website advertisements, and sending information to the 511 website. Finally, several survey respondents suggested radio ads and talks.

About 33% of respondents also suggested other locations where the snow-fence program can go to advertise. This includes: at herbicide trainings for farmers, through FSA or Pheasants Forever, through County Soil Conservation offices, at Farm Fest, at agricultural equipment dealers, and at other local farm shows or town meetings. About 11% of respondents suggested that the question did not apply to them or that this was a problem for "management to deal with." Finally, a few respondents also suggested making time and effort for one on one communication and sending trained employees to visit with landowners in areas where drifting snow is a problem.

2.2.27 Q27: How does implementing blowing-snow-control rank in your day-to-day work priorities?

63 individuals answered this question; three skipped it. Descriptive statistics are given in Figure 2.53.

Answer Choices	Responses
Very high	5% 3
Somewhat high	11% 7
Neutral	29% 18
Not very much	21% 13
Not at all	11% 7
Doesn't apply to me	22% 14
Other (please specify)	2% 1
Total	**63**

Figure 2.53 Blowing-snow-control Ranking in Daily Priorities Descriptive Statistics

Of the 63 individuals responding to this question, 18 of them (29%) reported that implementing blowing-snow-control is a "neutral" priority in their daily work. 14 individuals (22%) reported that this question does not apply to them. On the two ends of the spectrum, 10 individuals (16%) reported that implementing blowing-snow-control was either "very high" or "somewhat high" in their work priorities and 20 individuals (32%) prioritized it "not very much" or "not at all".

As the cross-tabulation in Figure 2.54 (job type x how does implementing blowing-snow-control rank in your work priorities) shows, program delivery staff were more likely to state that implementing blowing-snow-control does not apply to them. Maintenance operations staff are also more likely to say that blowing-snow-control is a high, somewhat high or neutral priority. This suggests a large gap in knowledge/awareness and points at an opportunity to raise the awareness of the benefits of snow-control such as safety to MnDOT staff especially program delivery staff.

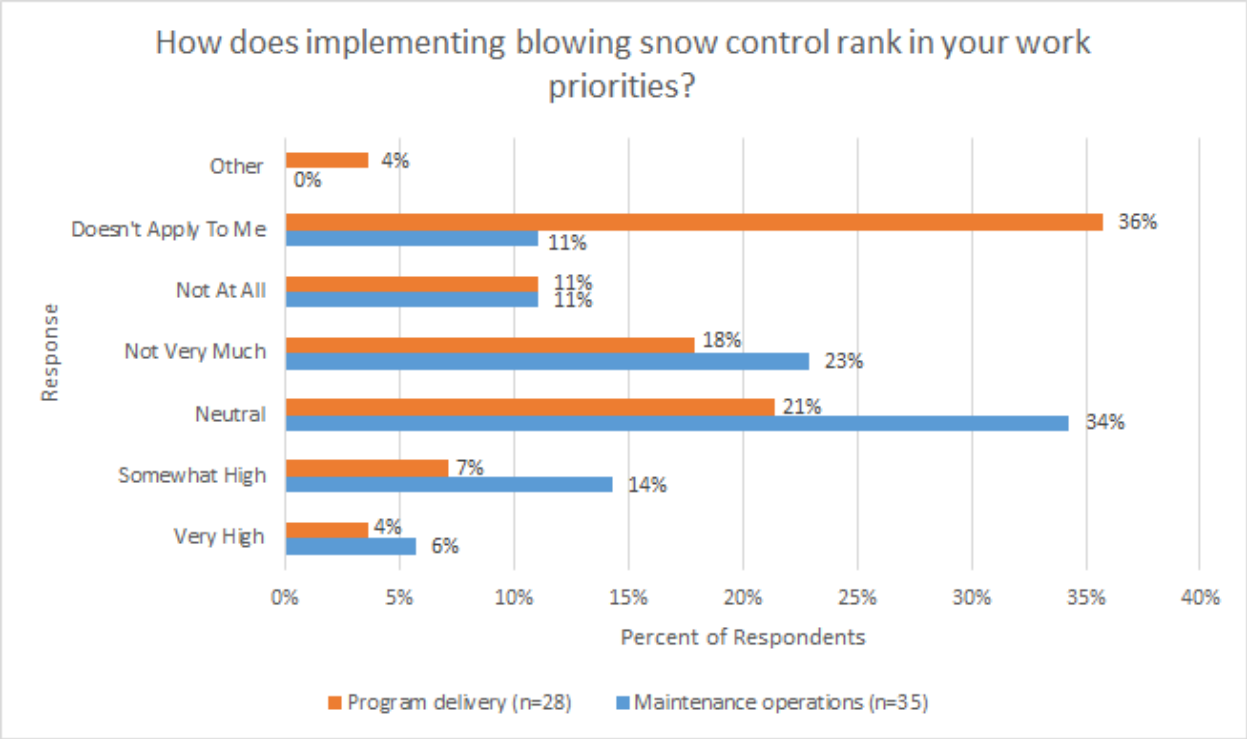


Figure 2.54 Blowing-snow-control Ranking in Daily Priorities Crosstabs

2.2.28 Q28: In your experience, does MnDOT's blowing-snow-control program have a favorable public image?

64 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 2.55 below.

Answer Choices	Responses
Favorable	17% 11
Somewhat favorable	17% 11
Neutral	28% 18
Somewhat unfavorable	2% 1
Don't know	34% 22
Other (please specify)	2% 1
Total	**64**

Figure 2.55 Blowing-snow-control Public Image Descriptive Statistics

Of the 64 respondents, 34% report that they do not know whether MnDOT's blowing-snow-control program has a favorable public image. The next most frequently selected response was that the program's public image is "neutral" (28%). 11 individuals responded that the program's public image is "favorable", and another 11 responded that it is "somewhat favorable" (17% for each). Additionally, one individual responded that the program's public image was "somewhat unfavorable" (2%), and another responded with "other" (2%). The individual responding with "other" left a comment explaining that the program's public image is favorable for the "traveling public", but "not so much" to landowners. The cross-tabulation in Figure 2.56 (job type x does MnDOT blowing-snow-control program have a favorable public image) shows that program delivery staff are more likely to not know if the snow-control program has a favorable public image. Program delivery staff are also more likely to think that the program's image is somewhat unfavorable. Maintenance staff are more likely to believe that the program's public image is favorable.

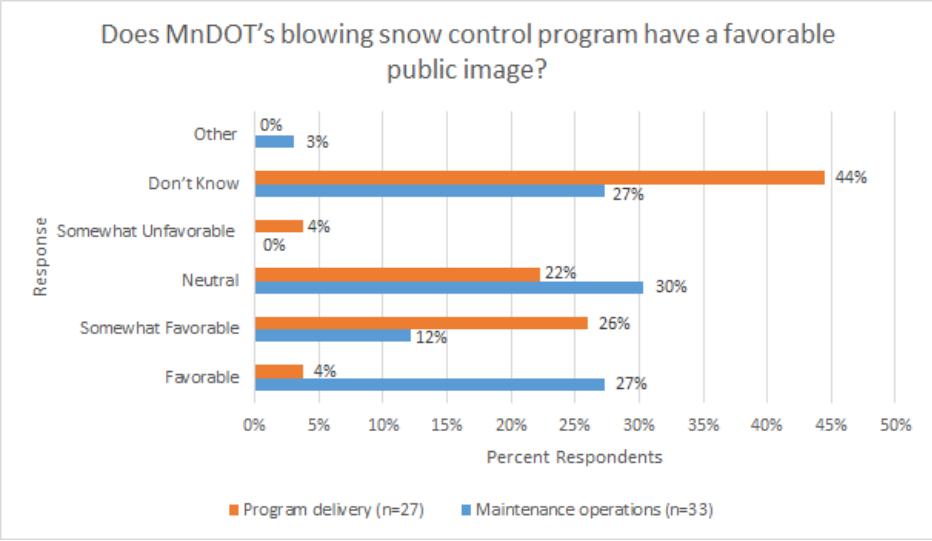


Figure 2.56 Blowing-snow-control Public Image Crosstabs

2.2.29 Q29: In your experience, is MnDOT's blowing-snow-control program favorably received by farmers?

63 individuals answered this question; three skipped it. Descriptive statistics are given in Figure 2.57.

Answer Choices	Responses
Yes	8% 5
Somewhat	25% 16
Neutral	14% 9
No	8% 5
Don't know	43% 27
Other (please specify)	2% 1
Total	63

Figure 2.57 Blowing-snow-control Favorably Received by Farmers Descriptive Statistics

Nearly half of the respondents (43%) reported that they do not know whether farmers favorably receive MnDOT's blowing-snow-control program. The next frequently reported response was that the program is "somewhat" favorably received (25%), followed by "neutral" (14%). At the two ends of the spectrum, the "yes" and "no" choices were indicated by five respondents each (8%). One respondent (2%) indicated "other", and left a note explaining that it depends on each individual's experience with MnDOT.

Both this and the question before suggesting that MnDOT employees generally do not know how others in the community view the blowing-snow-control program. Again, it is important to note that this is not a true measure of public opinion of MnDOT's blowing control but rather MnDOT employee's perception of public opinion. For more information on public opinion of these measures, further social research is necessary.

Figure 2.58 (job type x is MnDOT's blowing-snow-control program favorably received by farmers) shows that program delivery staff were much more likely to respond that they don't know the answer to this question compared to maintenance operations staff. Maintenance operations staff were also the only survey respondents that responded "yes" to this question and were more likely to respond "somewhat" than program delivery staff.

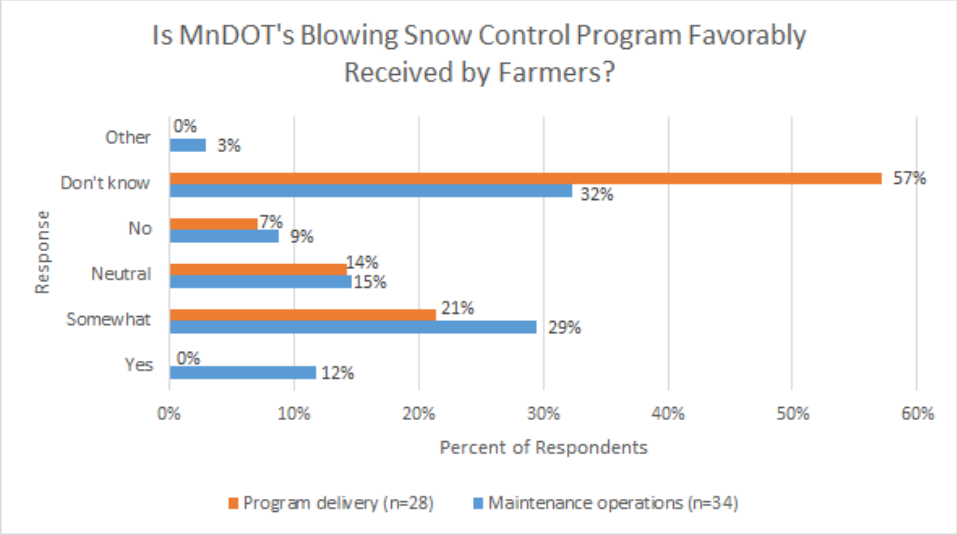


Figure 2.58 Blowing-snow-control Favorably Received by Farmers Crosstabs

2.2.30 Q30: In your opinion, what is an effective blowing-snow-control measure?

This was an open-ended question, asking respondents to write-in their answers. 31 individuals (47%) answered this question; 35 skipped it. Descriptive Statistics are given in Figure 2.59 below.

Survey Responses	**Responses**
Don't know, none or does not apply to me	13% (*n=4)*
Anything that landowners accept	16% (*n=5)*
Living snow-fences	26% (*n=8)*
Standing corn rows	35% (*n=11)*
Permanent measures	13% (*n=4)*
CRP grass fields	10% (*n=3)*
Total Respondents: 31	

Figure 2.59 Effective Blowing-snow-control Descriptive Statistics

Respondents' criteria of what makes a blowing-snow-control measure effective varied greatly. Some individuals listed specific practices, such as living fences or standing rows of crops, while others commented with social considerations or secondary benefits. Of the 31 respondents, four individuals (13%) replied with "none", "N/A" or with question marks, five individuals (16%) suggested that the

technology does not matter, but rather anything that will be accepted by landowners and implemented will help. The more socially-focused criteria mentioned by two respondents (6%) were acceptability (*"Anything that we can get the farmer to let us use."*), cost effectiveness and safety to the public. On blowing-snow-control practices: eight respondents (26%) mentioned living snow-fences, 11 (35%) mentioned standing corn or crop rows, 4 (13%) mentioned more permanent design-related measures, such as lowering of slopes, and three (10%) mentioned CRP grass fields.

2.2.31 Q31: Do you have any suggestions for the blowing-snow-control program?

This was an open-ended question, asking respondents to write-in their answers. 26 individuals (39%) answered this question; 40 skipped it. Descriptive statistics are given in Figure 2.60 below.

Survey Responses	**Responses**
No suggestions	31% (*n=8)*
Technical suggestions	12% (*n=3)*
Economic suggestions	15% (*n=4)*
Communication and marketing	31% (*n=8)*
Other	12% (*n=3)*
Total Respondents: 26	

Figure 2.60 Suggestions for Improvement Descriptive Statistics

Of those answering the question, 8 (31%) did not actually provide a suggestion. The remaining responses offered many suggestions that fell into a few overarching themes: technical (n=3, 12%), economic (n=4, 15%), and communication and marketing (n=8, 31%). Technical suggestions focused on increasing implementation of blowing-snow-control measures, both temporary and permanent. All four of the economic suggestions focused on promoting incentives for landowners to participate. The communication and marketing suggestions focused on various approaches to reaching out to landowners. A couple respondents commented on the importance of timing -- MnDOT should contact farmers early enough to influence their planting for the year. Respondents also suggested that MnDOT advertise the program through the media to increase awareness among landowners. A couple specific message-related ideas were presented. One individual suggested that photos be taken of key problem areas, showing a before and after story. Another suggested that specific information about rates per acre and other benefits be included in messages put out by the media.

2.3 CONCLUSIONS AND RECOMMENDATIONS

Analysis of the KAP survey results yielded several important considerations for designing a training. The following section summarizes these findings and provides recommendations for training.

2.3.1 Key Findings

2.3.1.1 Differing Knowledge and Perspectives between MnDOT Staff

A major conclusion revealed by the cross-tabulations by job type included in the analysis above is that the employees within the two different job categories (program delivery and maintenance operations) are very much distinct groups. While there is some crossover on questions of knowledge or attitudes, the two groups have unique experiences in their respective roles within MnDOT and different backgrounds and levels of familiarity with farming. For example, in Figure 3.2 the data shows that MnDOT staff employed in program delivery are relatively more removed from farming compared to employees involved in maintenance operations. This could have implications for the training requirements for these two sets of employees indicating that staff involved in program delivery may have less familiarity with farming practices and thus may require more training on the subject. In the context of this study's approach, they have unique gaps in knowledge and understanding. Therefore, the two groups will likely benefit most from different approaches and messaging, and thus should be addressed in separate trainings.

Based upon these findings we provided the following recommendations

- Tailor trainings to the two separate groups of MnDOT staff based upon the results of this analysis. Unique knowledge gaps for the two groups are included in the training recommendations in the sub-sections below.

2.3.1.2 Knowledge of Existing Blowing-snow-control Measures and Tools

Another important conclusion from this study is that MnDOT employees seem to have a knowledge gap regarding blowing-snow-control measures and tools. Questions 5 and 6 show that while most survey participants could identify standing corn and living snow-fences as measures currently used by MnDOT, they were significantly less aware of other blowing-snow-control measures. As seen in Question 7 ("Please indicate your familiarity with the following blowing-snow-control practices."), the majority of MnDOT employees, for all but one of the listed measures, have not personally worked with the measure. In general, program delivery staff were also less familiar with the blowing-snow-control practices compared to maintenance operations staff. Maintenance operations staff were more likely to report having used the different practices and program delivery staff were more likely to report that they were unaware of the different practices. However, program delivery staff were more likely to be aware of stacked corn or hay bales.

What's more, Question 9 revealed that most MnDOT staff are unaware of existing snow-control tools and those that are aware of these tools have never utilized them. In Question nine, which asked about respondents' familiarity with tools, a strong majority of respondents, indicated that they were not aware of all but one of the listed tools. The most utilized tool by survey respondents was the MnDOT living snow-fence website (16%). Only a very small percentage of survey respondents (3%-8%) used the other tools. No more than 41% of survey respondents have even seen any of the tools. The tools that survey respondents were least aware of included the Minnesota Winter Climate Design Tool and the CTS Snow-control Website. These results indicate opportunities to teach MnDOT staff about the existence of these various tools as well as encouragement of their use.

Recommendations for training:

- Training should include a review of existing snow-control tools and how to use them. Training should be designed to increase the awareness of the various tools and how they can be incorporated into MnDOT employees' jobs.
- A discrepancy in nomenclature was noted in the survey responses. In Question five, several survey respondents described the use of shrubs, trees and living snow-fences as a temporary measure. This may indicate a disconnect in understanding of living snow-fences within MnDOT, with some staff viewing them as temporary measures and others viewing them as long-term measures. Training should clarify the definitions of short-term versus long-term blowing-snow-control measures.

2.3.1.3 Knowledge of MnDOT's Current Snow-fence Program

Furthermore, the survey revealed that MnDOT employees have gaps in knowledge about MnDOT's current blowing-snow-control program. For example, in Questions 10 and 11, which asked respondents to name the District 8 and Statewide Snow-fence Coordinators, the clear majority were not able to do so. In addition, program delivery staff seem relatively less informed about MnDOT snow-fence program compared to maintenance operations staff.

Recommendations for training:

- Training should formally introduce the Snow-fence Coordinators and their respective roles in the program. By the end of the training, participating MnDOT employees should know who they are, how they can be contacted and how they can work together to increase adoption of blowing-snow-control measures.
- The coordinators should be more actively engaged with MnDOT staff, disseminating information and research results on a more regular basis.

2.3.1.4 Need to Clarify How Snow-fences Fit into MnDOT Staff Responsibilities

The survey results show that there is a lack of clarity in terms of whose responsibility it is to implement MnDOT's blowing-snow-control program, and how blowing-snow-control considerations relate to various roles within MnDOT. Program delivery employees do not view blowing-snow-control as a priority in their work. Furthermore, many program delivery employees do not view interaction with landowners as a component of their jobs. This was shown in the responses to Question 24, where the majority of program delivery staff indicated that interacting with landowners does not apply to them. This suggests that program delivery employees may not routinely interact with landowners as part of their jobs, and they may not recognize that interacting with landowners could be, or should be, part of their roles. Furthermore, this disconnect with landowners indicates that program delivery employees may not view the consideration of social implications as important when designing or repairing public highways.

There may be a lack of awareness about the importance of snow-fences and a need for training to show the importance of these measures with this group. For many MnDOT employees, the connection between blowing-snow-control and their current roles and responsibilities is not clear. This connection must be strengthened.

Recommendations for training:

- Trainings should highlight the various ways in which blowing-snow-control impacts employees' work, and why blowing-snow-control should be prioritized, regardless of one's technical focus within MnDOT. Information about the benefits of snow-fences (concerning budget, public safety etc.) should be included in trainings for all employees.
- In addition to the MnDOT-wide benefits of increasing adoption of blowing-snow-control measures discussed above, trainings should highlight the specific ways in which blowing-snow-control considerations relate to employees' roles. This could be done in training sessions targeting program delivery and maintenance operations separately, as the connections will vary greatly between the two groups.

2.3.1.5 Addressing Barriers and Training Needs Identified by MnDOT staff

Question 19 in the KAP survey asked, "What prevents you from implementing snow-control measures?" While most respondents responded with "don't know," the other most frequently selected responses included lack of knowledge, not a priority, lack of training, lack of funding and lack of time/compensation. Program delivery staff were more likely to report that they do not know what the barriers to implementation are while maintenance operations staff were more likely to select time/compensation, knowledge, training, and funding. Question 20 in the KAP survey asked, "What would help you to implement snow-control measures?" While most respondents responded with "don't know", the other frequently selected responses focused on training needs, specifically about MnDOT's

blowing-snow-control program/incentives and communication with landowners. Meanwhile, survey respondents less frequently selected overtime/compensation and recognition.

Finally, Question 23 asked, “What do MnDOT employees need to know so they can better communicate with landowners about blowing-snow-control?” The most commonly selected answers (in order) were: the costs/benefits of blowing-snow-control, a greater understanding of MnDOT’s blowing-snow-control process and standard operating procedures, knowledge about blowing-snow-control measures technical aspects, communication skills and conflict management skills. Maintenance operations staff were more likely to identify communication skills and knowledge of MnDOT’s process as information that they would need to know. Program delivery staff were more likely to identify cost/benefits, technical knowledge, and conflict management skills.

Recommendations for training:

8. These results support MnDOT’s initial assessment that employees would benefit from more training on blowing-snow-control measures and approaches for increasing implementation.
9. Maintenance operations staff reported that program/incentives training and communication training would help them implement snow-control measures.
10. Program delivery staff were more likely to report that technical training and recognition are important.

2.3.1.6 Knowledge of Landowner Perspectives

This study highlights an important gap in knowledge relating to the perceptions and motivations of landowners. For all the survey questions relating to landowners' opinions or concerns, the most frequently selected answer was "don't know". This indicates that MnDOT employees do not have any certainty about landowners’ opinions regarding blowing-snow-control measures, what would help them to implement blowing-snow-control measures on their land, what is preventing them from implementing blowing-snow-control measures, or how they would prefer to be approached by MnDOT employees. It should be noted that, while this was an overall trend, the cross-tabulated data shows that MnDOT staff involved in program delivery are even more likely to report that they do not know about landowners’ perspectives compared to maintenance operations staff.

2.3.2 Recommendations for Future Research

Though there were many questions included in this survey relating to landowner perceptions and motivations, it is important to remember that the results do not directly represent actual landowner opinions. Rather, the results from this survey merely illustrate MnDOT employees’ perceptions about landowners’ opinions. Thus, MnDOT should not use this information to make conclusions or programmatic decisions related to actual landowner opinions.

The survey results do reveal that MnDOT tends to naturally orient towards financial and technical approaches, such as easements and incentives. However, past studies on landowner attitudes and practices have shown that there may be other, perhaps more effective, methods of obtaining landowner interest in addition to the approaches that MnDOT is currently using. Landowners may have other influential motivations relating to issues of safety, legacy or social conscience.

At this point, the main blowing-snow-control challenges faced by MnDOT are not technical, but rather they are related to the social problem of adoption. Understanding the complex social dimensions of blowing-snow-control is a necessary next step. Further research on landowner perceptions and motivations, in the form of a comprehensive and rigorous survey, will help MnDOT design new solutions and more effectively reach out to landowners. Key issues, such as differences in land ownership (renters versus owner operators) and their impacts on adoption, should be explored.

2.3.3 Recommendations

2.3.3.1 Research Recommendations

MnDOT should consider conducting a study directly focusing on landowner knowledge, attitudes, and practices regarding blowing-snow-control measures. The study should explore potential differences in willingness to adopt based on land ownership or tenancy characteristics, as well as the effectiveness of a range of approaches beyond just financial incentives.

MnDOT should consider opportunities for incorporating participatory approaches into their research to engage landowners and encourage collaboration.

2.3.3.2 Summarized Training Recommendations

Strengthen Connections between Blowing-snow-control and MnDOT Employees' Work: Trainings should highlight the various ways in which blowing-snow-control impacts employees' work and why blowing-snow-control should be prioritized, regardless of one's technical focus within MnDOT. Information about the benefits of snow-fences (about budget, public safety etc.) should be included in trainings for all employees.

In addition to the MnDOT-wide benefits of increasing adoption of blowing-snow-control measures, trainings should highlight the specific ways in which blowing-snow-control considerations relate to employees' roles. This could be done in training sessions targeting program delivery and maintenance operations separately, as the connections will vary greatly between the two groups.

Address Gaps in Technical Knowledge of Measures, Tools and MnDOT's Program: Include a review of best practices for implementing blowing-snow-control. Review snow-control measures currently utilized by MnDOT, focusing on those measures that were least recognized by survey participants, such as

stacked corn or hay bales, temporary fences, mechanically wind-rowing snow, and structural snow-fences. Training should provide a common understanding of blowing-snow-control measures and clarify the definitions of short-term versus long-term blowing-snow-control measures. Training should include a review of existing snow-control tools and how to use them. Training should be designed to increase the awareness of the various tools and how they can be incorporated into MnDOT employees' jobs. In addition to promoting awareness, providing opportunities to practice with the tools during the training is recommended. Review the costs and benefits of blowing-snow-control, from perspectives of landowners and MnDOT. Review MnDOT's current blowing-snow-control process and standard operating procedures. Review technical aspects of blowing-snow-control measures. Training should formally introduce the Snow-fence Coordinators and their respective roles in the program. By the end of the training, participating MnDOT employees should know who they are, how they can be contacted and how they can work together to increase adoption of blowing-snow-control measures.

Develop Communication Skills: Include training on interacting/communicating with landowners. This should focus both on the importance of communicating with landowners as well as methods for effectively communicating with landowners.

Tailor trainings to the two separate groups of MnDOT staff. Based upon the results of this analysis, the following job-group based suggestions exist:

For program Delivery Staff: there should be more focus upon cost/benefit training and promoting technical knowledge of the program. Program delivery staff are more removed from farming and are therefore likely more likely to require more training regarding the context of farming in Minnesota compared to their counterparts in maintenance operations. Program delivery staff were much more likely to be unaware of landowner perceptions and willingness to adopt permanent snow-control measures. More training on communication and the importance of interaction with landowners is recommended.

For maintenance operations staff: we recommend more focus on communication skills during training, and more focus on MnDOT's current Blowing-snow-control Program Standards of Operations and incentives.

Recognition: Finally, we recommend that MnDOT Offer a certification to participants in the training to provide recognition for their participation.

CHAPTER 3: OVERVIEW OF STATE SNOW-FENCE PROGRAMS AND LANDOWNER RESEARCH

3.1 OVERVIEW

Snow-fences are used throughout the Northern United States as a tool to protect public roads and highways from blowing-and-drifting snow. These structures often go unrecognized and underappreciated for their role in preventing winter-weather related crashes and saving thousands of taxpayer dollars through avoided snowplowing and de-icing. Snow-fences cause snow to accumulate off the roadway by acting as porous windbreaks rather than physical barriers (D'Alto, 2012). As Figure 1 below illustrates, when wind hits a snow-fence the structure acts as a windbreak causing the wind to lose speed and energy. As the wind's velocity decreases, snow particles that had previously been carried by the wind begin to drop to the ground. This causes snowdrifts to form upwind and downwind of the fence before the snow can reach the road (D'Alto, 2012)

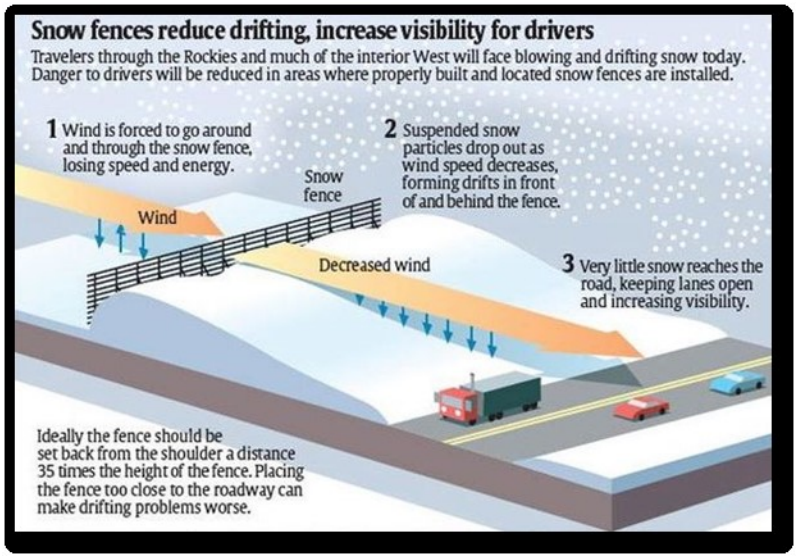


Figure 3.1 Diagram of How Snow-fences Work

Snow-fences come in many forms including permanent wooden structures, temporary removable structures, permanent living snow-fences (LSFs) and snow-fences made from standing cornrows. Permanent snow-fences have traditionally been wooden structures but can also be constructed of metal, plastic or other materials. They are placed off the roadside and remain on the property throughout the year. As the name implies, temporary snow-fences can be plastic, wooden or other materials and are installed and uninstalled every winter. Living snow-fences (LSF) can be trees, shrubs or native grasses planted along roads or around communities. These permanent plantings trap snow as it blows across fields before it reaches the road (MnDOT, 2015). LSFs are often seen as the most-cost effective type of snow-fence. Research conducted at the University of Minnesota shows that there is an

average benefit/cost ratio of 17:1 when utilizing LSFs in lieu of snow removal (CTS, 2015). This high benefit cost ratio is because once established a LSF has a long service life and low annual maintenance costs (CTS, 2015). Standing cornrow snow-fences are temporary fences that take advantage of cornfields. Landowners typically leave several rows of corn standing over the winter to act as a snow barrier. Cornrow fences are a convenient option in areas where farmers are unable or unwilling to give up a portion of their property to a permanent structure.

Snow-fences' ability to prevent snow from accumulating on roads serves to reduce travel times and increase public safety by increasing driver visibility, improving road conditions and preventing crashes. In fact, in Minnesota it was found that snow-fences reduced crashes on super elevated curves by 40% (Wyatt, et al. 2015). These fences also save the state thousands of tax dollars by preventing costs associated with plowing, ice-removal, and infrastructure damage (Wyatt et al, 2012). It has been estimated that costs associated with these activities alone annually exceed US$7 billion in the United States (Isrebrands et al, 2014).

Snow-fences also provide significant environmental benefits. Preventing snow-buildup reduces the need to apply salt preventing chloride from salt from draining into local watersheds. Chloride concentrations from salt can harm local fish and plant life and increase the mobility of dangerous metals located in soils along major highways (Zamora et al, 2015). Living snow-fences can also provide important wildlife habitat along state highways, prevent erosion and intercept runoff (Wyatt et al, 2012; MnDOT, 2015). Some species used as living snow-fence species (such as willows) are also a food source for pollinators (Voughan & Black, 2006). In addition to reducing carbon emissions associated with snowplows, living snow-fences also serve to sequester carbon (Wyatt et al, 2012; MnDOT, 2015).

Due to these benefits, state departments of transportation as well as researchers from around the country have continuously worked to improve snow-fence design and cost-effectiveness. The University of Minnesota has collaborated with MnDOT to develop several tools to facilitate the use of snow-fences including:

- A cost benefit tool that allows transportation agencies to estimate their potential return on investment for implementing different types of snow-fence.
- A design tool that helps interested parties design site-specific solutions to blowing-snow problems using snow-fences (CTS, 2015).

Several other states have published snow-fence design guides and the New York Department of Transportation worked with the University of Buffalo to develop a Snow Management Software (called SnowMan for short) application which allows highway engineers to analyze different options for mitigating blowing-snow using snow-fences or highway modification (Chen & Lamanna, 2008).

Despite the many benefits that snow-fences provide as well as the many tools that are available to facilitate fence design, a major obstacle to the use of snow-fences has been landowner interest. As Figure 1 showed, snow-fences must be set back from the roadway to allow sufficient catchment area

and ensure that the fence does not cause snow to drop directly on the roadway. This means that the ideal location for snow-fences is often off the public highway right of way on private property. Despite the potential benefits, landowner willingness to install snow-fences on private property throughout Minnesota has remained low (Wyatt, et al. 2015).

This research aims to expand the investigation of landowner adoption from Minnesota to the other states that routinely utilize snow-fences as a snow management tool. While snow-fences are a well-recognized snow management tool, landowner engagement is a subject that is very rarely addressed in the existing literature. To address the problem of landowner adoption, this research aims to provide a detailed overview of existing state snow-fence programs in the United States and to describe the common factors related to program design and public outreach that affect program success. In doing so, this analysis aims to serve as a resource for states looking to address the challenge of landowner adoption in snow-fence programs

3.2 METHODS

This study aims to describe the variety of the different snow-fence programs that exist within the United States including how they are implemented and how they conduct landowner outreach. The goals of this research were to identify:

- Common obstacles that snow-fences programs face when attempting to engage landowners
- Common characteristics of snow-fence programs that can effectively engage with landowners
- Future opportunities for snow-fence programs to improve landowner adoption.

The study was conducted between September 2015 and January 2016 and included three distinct phases:

Phase 1: Literature Review

The first phase of the study involved a detailed literature review of existing information related to the design of existing snow-fence programs and the public engagement techniques used by these snow-fence programs. During the literature review, the following forms of documentation were analyzed: newspaper articles, snow-fence program website, department of transportation websites, grant program descriptions, snow-fence design manuals, project reports, snow-fence program brochures, snow-fence program contracts, peer-reviewed publications and other sources.

Phase 2: Telephone Interviews

In addition to the literature review, semi-structured phone interviews were conducted with representatives involved in snow-fence programs throughout the United States. Phone interview participants were identified based upon the available contact information on state programs identified during the literature review and contacted via email or phone calls. If no contact information was found during the literature review, state departments of transportation were cold-called, and snow-fence

program managers were requested. In total 33 representatives from 25 states were contacted during the interview phase of this project. Interviewees included representatives from: Departments of Transportation (supervisors and field staff), State Forest Services, Departments of Natural Resources, Extension offices, Conservation Districts, Natural Resource Conservation Service, Departments of Agriculture, etc. Interviews varied greatly in length from 15 to 60 minutes. Questions during the interview focused upon program design, outreach, strengths, obstacles to implementation, and ideas for improving outreach in the future. A full copy of the interview guide used during these interviews can be found in the appendix of this document.

Phase 3: Data Analysis

During the final phase of the study data from the phone interviews were coded and analyzed to identify general themes related to common characteristics of successful snow-fence programs as well as major obstacles to landowner outreach.

3.3 RESULTS

3.3.1 Existing Snow-fence Programs

As Figure 3.2. below shows, 18 states currently routinely utilize snow-fences on public and/or private property. Three additional states (Nebraska, South Dakota and Pennsylvania) have used snow-fences in the past but have since discontinued their programs. Several additional states use one or two snow-fences in very specific problem areas (Arizona, California) or implement windbreak programs that could include snow-fences (Alaska). Perhaps unsurprisingly, this map shows that snow-fence programs are mainly concentrated in the Northern-most portions of the country that typically experience the most severe winters. The appendix of this paper contains a detailed description of current and past snow-fence use in each state.

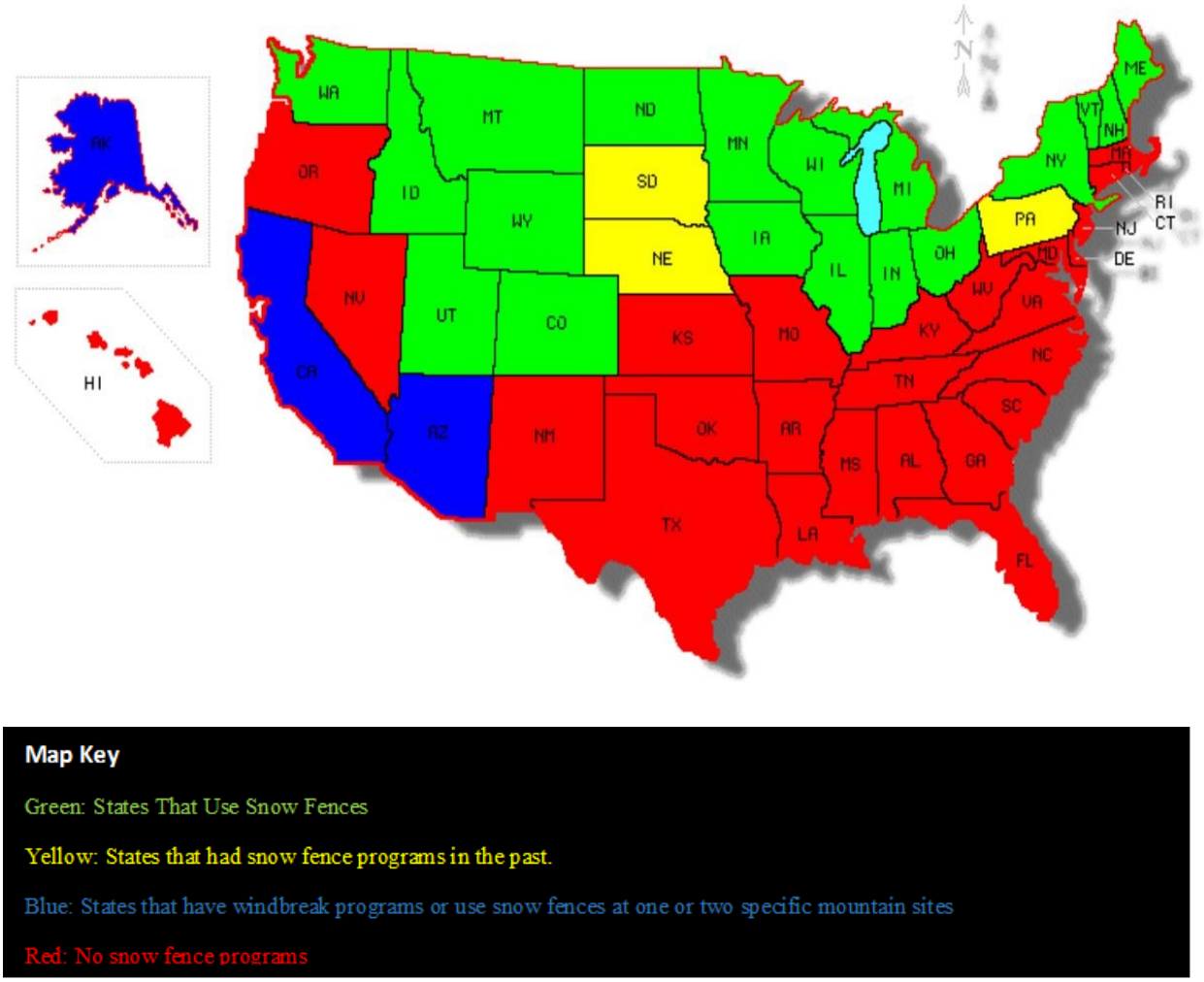


Figure 3.2 State Snow-fence Program Map

Table 3.1 Existing Snow-fence Program Characteristics

Existing Snow-fence Program[2] Characteristics				
State	**Program Scale**	**Type of Fences**	**Funding Source**	**Current Implementing Agency or Agencies**
Colorado	8 Counties	LSF	Federal Programs i.e.: CRP & EQIP	Conservation Districts and Extension Offices
Idaho	South Idaho	Permanent Structures	Idaho Transportation Dept. (ITD) Budget	ITD
Illinois	County	Temporary	County DOT Budgets	County DOTs
Indiana	State-Wide	LSF	CRP	NRCS
Iowa	State-Wide	LSF, Corn Row, Temporary and Permanent Structures	Iowa DOT Snow-fence Budget[3] and CRP (for LSFs)	IowaDOT
Maine	Northern Maine	LSF and Permanent Structures	MaineDOT Budget	MaineDOT
Michigan	State-Wide	Temporary	MDOT operations Budget	MDOT
Minnesota	State-Wide	Permanent Structures, LSF, Corn Row	MnDOT Budget, and federal programs i.e.: EQIP & CRP	MnDOT
Montana	State-Wide	Permanent Structures	Federal roadway funding during road construction or repair. Outside of road construction project are funded by MDT Budget.	MDT
New Hampshire	State-Wide	Temporary	NHDOT District Budgets	NHDOT
New York	State-Wide	LSF, Corn Row, Temporary & Permanent Structures	Regional DOT Budgets. Training and research is funded by the SP&R Fund	NYSDOT and NY Thruway Authority

[2] Most state DOTs do not actually have official snow-fence programs but rather utilize snow-fences as a snow management tool in problem areas throughout the state as needed.
[3] IDOT currently has $130,000 set aside for snow-fences on state or interstate highways. The state snow-fence budget is relatively flexible and is adjusted based upon demand and fluctuations in crop pricing.

North Dakota	State-Wide	LSF	NDDOT District Operations Budget	NDDOT
Ohio	Northwest Ohio	Temporary, Corn Row, Permanent & LSF	ODOT District Budget, CRP and PREP for LSFs	ODOT
Utah	State-Wide	LSF, Temporary and Permanent Structures	UDOT Budget	UDOT and local counties
Vermont	State-Wide	Temporary	VTrans Budget	VTrans
Washington	Small-Scale Community Projects	Temporary and LSF	Local county budgets as well as the federal CRP program for LSFs	Varies
Wisconsin	State-Wide	LSF and Corn Row. Some Temporary & Permanent Structures	WisDOT budget or the Federal HSIP[4].	WisDOT
Wyoming	State-Wide	LSF and Permanent Structures	WYDOT provides $100,000 in funding annually to the program.	WyDOT, Wyoming State Forestry Division, & conservation districts

As Table 3.1 shows, existing snow-fence programs vary greatly in terms of scale, type of fencing, funding source and implementing agency. Snow-fences are typically used by state or local departments of transportation. However, some programs are implemented by federal agencies, conservation districts or extension offices. Wyoming's program is unique in that it is implemented collaboratively between several agencies. In Wyoming, the Department of Transportation provides funding, and the Wyoming State Forestry Division oversees the program. Program outreach, design, and implementation are conducted by local conservation districts[5].

As Table 3.1 demonstrates, the majority of snow-fence program funding comes from state or local transportation department budgets. While Wyoming and Iowa have specific funds set aside ($100,000 and $130,000 respectively) specifically for snow-fence programs, most state DOTs fund snow-fence programs through their general maintenance or winter maintenance budgets. For living snow-fences, states can utilize sources of federal conservation funding to supplement or completely fund their snow-fence programs. The two most common forms of federal funding available to landowners include:

[4] The majority of funding for LSFs comes from WisDOT's vegetation fund and funding for structural fences comes from maintenance project budgets. For some highway improvement projects, especially highway safety improvement projects where a majority of the crashes are winter related, WisDOT tries to use HSIP funds.

[5] In the past Colorado, South Dakota and North Dakota also had snow-fence programs implemented collaboratively between several agencies. The main reasons cited for the dissolution of these collaborative programs were 1) lack of funding and 2) lack of landowners and/or implementing agency interest. See state descriptions in appendix for more information on past collaborations.

- The Continuous Conservation Reserve Program (CRP) through the Farm Services Agency (FSA) which will pay the landowners an annual rental rate for 15 years on the acres removed from farming production. FSA will also pay a percentage of the installation costs.
- The Environmental Quality Incentives Program (EQIP) through the Natural Resources Conservation Service will also pay a percentage of installation costs and is used on areas that have not been farmed like rangeland.

Additional sources of federal funding that state representatives reported using were the Federal Highway Safety Improvement Program (HSIP) and the Federal State Planning and Research (SP&R) Fund for research and training.

Table 3.1 shows that the scale of snow-fence programs varies greatly between states. Fences are typically installed in a targeted manner with local DOTs identifying existing or potential problem areas and siting fencing accordingly. Most states report that most snow-fences are concentrated in specific regions that have climatic, topographical and land-use characteristics that make roads susceptible to blowing-snow.

3.3.1.1 Types of Snow-fence Used

Table 3.3 shows that while 50% of states utilize only one type of snow-fences the other 50% often use two or more types of snow fencing based upon the best fit for local conditions. Of the 18 states that use snow-fences, 12 use living snow-fence, five use cornrow fencing, ten use temporary fencing, and 10 use permanent fencing.

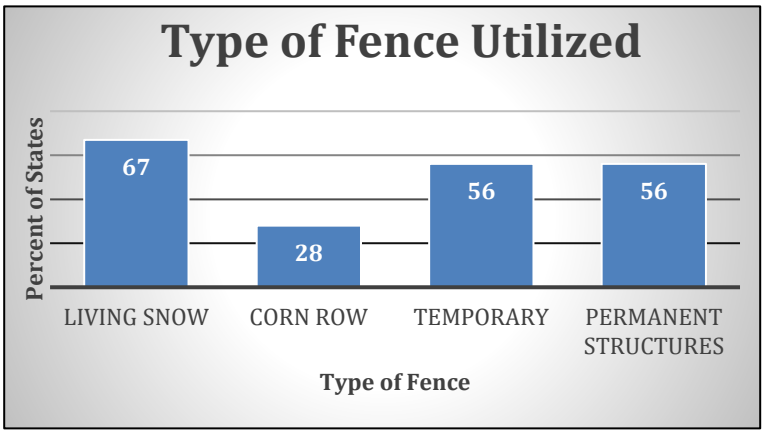


Figure 3.3 Type of Fence Used

Living Snow-fences[6]

[6] More information about states with LSF programs (such as New York, Wyoming, Colorado and North Dakota) can be found in the appendix.

The type of snow-fence used by the largest percentage of states is the living snow-fence. Some reasons that state representatives gave for utilizing LSFs included their high cost-benefit ratios compared to other snow management options (CTS, 2015) as well as the availability of a funding source. For example, Wisconsin's state funding for roadside plantings has influenced the state's focus on living snow-fences. Despite their benefits, states also mentioned several constraints to using LSFs. These constraints include:

- Space requirements for LSFs are higher than some of the other snow-fence options.
- It takes several years for LSFs to establish. During this time, they do not provide much snow-control and require extra maintenance.
- Site conditions such as unfavorable climate and soil conditions can sometimes prohibit the use of LSFs (WSFD, 2015).

For LSF programs, implementing organizations typically install the fences, and often provide the trees. Some programs will also provide maintenance for the snow-fences until they are established. When LSF programs provide payments to landowners for maintenance and/or the use of their property this money often comes from a federal program (CRP or EQIP), the state DOT budget or both. Landowners are typically required to maintain the fences on their property once they are established and typically sign contracts that range in time from 10 years to 30 years[7].

The main factor that is considered in LSF species selection is the appropriateness for local soil and climatic conditions, which directly influences the likelihood that the LSF will survive on the site. Minnesota and New York are the only states that have researched tree species with additional economic potential. Both New York and Minnesota have considered willows as a source of bioenergy and snow fencing (Zamora et al, 2015; Heavey et al, 2015). Researchers at University of Minnesota have also investigated other plant species for their economic potential as a means of adding value to the fences for landowners (Streed & Walton, 2001).

Corn Row Programs

Minnesota, Wisconsin and Iowa currently routinely use standing cornrow fencing as a means of controlling blowing-snow on state highways. The major reason that representatives gave for using the cornrow fencing is that it seems to be the most convenient option for landowners. Landowners are often unwilling to install structures or LSFs on their property due to the inconvenience the fencing causes to their operations and the land that is taken out of production. The compatibility of the cornrow programs to landowner needs is what makes it attractive to landowners compared to other types of snow-fence.

Cornrow programs typically utilize seasonal contracts due to the common practice of crop rotation. Minnesota pays landowners on a per acre basis and utilizing the University of Minnesota's cost-benefit

[7] Wyoming is the only state with a 30-year contract.

tool to justify the investment (payments using this tool average $1000 per acre)[8]. Wisconsin currently pays landowners 50 cents per bushel[9] more than market price and Iowa pays a flat rate of $5/bushel. The corn can be hand-harvested or harvested in the spring and landowners can use the corn as a tax write-off. Minnesota and Wisconsin have also connected farmers with local community groups to hand pick the corn.

Permanent Snow-fences

56% of states that use snow-fences use permanent structures. Compared to LSFs, permanent snow-fences are convenient in locations that require immediate snow protection or in locations with poor soil and climate conditions that will not support living snow-fences. Payments to landowners for permanent fencing varies between programs. Maine does not offer landowners any compensation to install permanent fencing on their property. While Montana's DOT prefers to purchase land from landowners via easements, the state will also sign annual leases and with landowner and pay the land rental value. Iowa pays landowners $1 per linear foot and landowners sign 5-year contracts. Fences are typically maintained by the state DOT.

Temporary Snow-fences

Like cornrows, temporary fences are often utilized in situations where landowners are unwilling to allow a permanent fence on their property[10]. The DOT installs and removes the fences each season. Typically, landowners do not receive payments for the fences. While some states sign contracts with landowners for the temporary fencing, other states install the fences based upon verbal agreements with the landowner.

Other Snow Barrier Options

Some states also use snow trenches (also known as windrowing snow) or berms in areas where landowners are unwilling to allow any form of fencing on their property. For snow tranches, the DOT maintenance crew uses machinery to dig out a deep trench in pre-existing snow. The trench captures drifting snow, eventually fills up, and is dug out again as needed by DOT maintenance. Similarly, snow berms are formed by piling snow into a barrier. While neither technique is as effective as snow fencing, they make a difference in problem areas and are often seen as the best option available in situations where fences are not feasible.

[8] For more information or to use the tool visit: http://snowcontroltools.umn.edu/costbenefit/
[9] There are plans to increase this payment to $1.50 per bushel.
[10] States that primarily rely upon temporary snow fencing include Illinois, Michigan New Hampshire, and Vermont.

3.3.1.2 Landowner Engagement and Outreach

While states such as Minnesota, Iowa, North Dakota, and Wyoming engage landowners to set up fences on private property, other states avoid working with landowners. These states install fences on state property or purchase easements from landowners rather than engaging in long-term contracts with private landowners. Purchasing easements ensures the long-term continuity of the fences on the property[11].

Most commonly outreach for snow-fence programs is extremely targeted and focuses upon specific tracts of road that have snowdrift problems. However, some states such as Iowa have a broader outreach program and publish information on their websites, in brochures, on the radio and on social media[12]. Many states suggest expanding outreach to the public to promote a general understanding of what snow-fences are and how they benefit the local environment and community can significantly improve public understanding and awareness of snow-fence programs. This awareness helps promote landowner adoption. As one snow-fence program representative explained, public outreach explaining snow-fences helps the public understand the actions of DOT and trust that these agencies are being good stewards of taxpayer dollars. The following sections will discuss this topic further.

[11] It is important to note that land prices vary greatly between states and land prices are typically lower in these Western states compared to Minnesota and other states with significant agricultural production.
[12] Visit: http://kiwaradio.com/local-news/dot-looking-for-corn-snow-fence-opportunities/ to see an example of a recent radio interview aimed at recruiting participants for Iowa's Standing Corn Row Program. The appendix also contains examples of brochures and websites used for outreach.

3.3.2 Factors that affect landowner adoption of snow-fence programs

Based upon the literature review and conversations with state snow-fence program representatives it was possible to identify several program characteristics that contributed to program success as well as several obstacles to success. These factors are summarized in Table 3.2. below:

Table 3.2 Factors that Impact Landowner Adoption

Factors that Impact Landowner Adoption
Common Characteristics of Strong Programs
• Strong Relationships with Landowners • Direct Communication with Landowners • Collaboration and Coordination Between Different Organizations • Flexibility • Experimentation with fence placement and design to fit local conditions • Funding • Observable Benefits • Landowners Interested in Public Safety and/or Conservation Benefits • Excellent Snow-fence Maintenance • Severe Winter Conditions That Generate Interest in Blowing-snow-control
Common Challenges/Obstacles
• Landowner Inconvenience • Poor Relationship Between Landowner and Implementing Agency • Fluctuations in DOT interest • Intimidating Contracts
Potential Opportunities
• New Research • Value-Added Products • Staff Training • New Collaborations • Program Promotion

3.3.2.1 Characteristics of Strong Programs

I. Strong Relationships with Local Landowners

Many program representatives emphasized that maintaining strong relationships through one-on-one communication with landowners is key to the success of snow-fence programs. Strong relationships help establish trust between the landowner and snow-fence program. They also help the implementing agency understand the factors that facilitate or detract from program adoption. Without strong relationships, it is more difficult to approach landowners about the program and less likely that landowners will be willing to consider participation. In fact, several state agencies maintained that landowner mistrust of government agencies was a major factor contributing to landowner refusal to participate in snow-fence programs.

States use a variety of different means to maintain close relationships with landowners. In many states, rural DOT field staff are from the local community and often know local landowners outside of the DOT setting. Some field staff are even farmers or landowners themselves. They have a distinct advantage when reaching out to landowners as it is easier for them to approach landowners and they are very knowledgeable about the program. In other states, implementing agencies rely on local conservation districts for outreach. Conservation district employees often have positive pre-existing relationships with local landowners and are in-tune with local conditions and landowner needs. For example, in Wyoming, program coordinators emphasized the benefits of collaboration with local conservation districts. Often, conservation district employees have grown up in the area, so it is easy for them to contact and talk with the landowners. Landowners in Wyoming also seem more willing to work with conservation districts compared to the state agencies. The large size of these centralized agencies makes them less able to maintain the one on one communication necessary to maintain relationships with landowners throughout the state. Past problems between the DOT and landowners can also sour relationships and perceptions making it difficult for DOT staff to establish relationships.

II. Direct Communication

Almost unanimously, program representatives report that direct communication was the best way of engaging with landowners. This direct communication allows program representatives to develop a relationship with landowners and have more in-depth conversations about what they want to do with the snow-fences, what the benefits will be, and any of the specific requirements that landowners have for the snow-fences. Speaking with landowners face to face also help agency staff answer questions, address concerns and troubleshoot potential problems with landowners.

III. Coordinated Collaboration

A survey conducted by SUNY-ESF found that working with local partners to convey information and training was a factor that was commonly hailed as effective (Williamson & Volk, 2009). Collaboration allows agencies to coordinate expertise and resources. For example, in Wyoming WyDOT collaborates with the State Forestry Division and local conservation districts to implement a LSF program. WYDOT

provides funding and the State Forestry Division oversees the program. Program outreach, design, and implementation is conducted by local conservation districts. Prior to construction, an outside committee also reviews all projects. In Montana MDT has collaborated with local building and flooring businesses to maintain their wooden snow-fences. The businesses will maintain the fences and replace the wood free. The businesses can sell the reclaimed and weathered wood as furniture.

IV. Flexibility

Snow-fence programs are strongest when they have the flexibility to adapt fence design, location, and contracts to local conditions and landowner needs. While it is necessary to work within certain design constraints to ensure that snow-fences keep drifts off the roadway, flexibility allows states to adapt snow fencing to existing infrastructure and local environmental or social conditions. Snow-fence programs with rigid design and eligibility requirements are less able to change to address landowner needs and concerns making participation more difficult. One state representative also pointed out that perfect conditions for snow-fence design and location often do not exist. While scientifically tested guidelines are helpful, DOT staff work with many different terrains and constraints that do not match the conditions that existed during scientific studies. It is important to ensure that DOT staff are not discouraged by local conditions and are able to break away from the idea that conditions need to be perfect for the fences to function. This allows agency staff to innovate with snow fencing that best serves local conditions.

V. Experimentation

Using monitoring and evaluation to identify how fences perform based upon local constraints has become an important part of snow-fence program implementation. Experimenting with different approaches to fence design and program development allows snow-fence programs to identify the best course of action for local conditions. For example, in Montana MDT experimented with old guardrail posts stacked in a jigsaw design instead of the typical wooden fencing after landowners complained that they did not like how fences looked in their fields. The old guardrail posts were not being used after federal safety standards required them to be replaced with a safer material. Landowners were more willing to allow the guardrail fences in their property and the MDT could re-use old materials. In Iowa, IDOT allows for some flexibility and experimentation in the design of the snow fencing based upon the ideas and suggestions of experts, local field staff, and landowners. This year IDOT has one area where corn was left on both sides of the road to see how a different configuration will work in an area that has had many problems with drifting snow in the past. IDOT has also experimented with using corn bales as a snow-fence in the past. In the future, IDOT is hoping to study whether leaving corn stubble or residue on the ground after harvest will have a positive effect.

VI. Funding

In addition to indicating a high level of internal DOT support and prioritization for snow-fences, well-funded programs can offer competitive landowner incentives and/or compensation. Financial

compensation coupled with the additional community safety and wildlife/livestock shelter that the fences provide make them an attractive option for landowners. One of the main strengths of Iowa's cornrow program is the price at which IDOT buys corn, which is more than what farmers would get at the grain elevator. Landowners can also use the corn as a tax write-off and harvest the crop in the spring. People easily realize that the program is the best option for their product economically. Competitive financial compensation for landowners is not the only potential benefit of well-funded programs. Well-funded programs can allocate sufficient funds to promotion, installation and maintenance of snow-fences. Several states that recently cancelled or scaled-down programs cited cancellation of funding as a major barrier to continuation.

VII. Landowner interest in conservation and/or public safety

Landowners with interest in public safety or conservation are more likely to value the added conservation and safety benefits provided by the snow-fences even if financial compensation is not as competitive as other options. As one representative from Ohio pointed out, while the funding allows the landowner to participate they still must have conservation interest to be willing to engage with the program. For example, in Ohio the program is primarily wildlife-oriented in terms of reasons why people participate. Many representatives also say that community members often participate due to public safety concerns.

VIII. Observable Benefits

Snow-fences on roads where their benefits are easily observable help generate public awareness, understanding and appreciation for snow-fence programs. Landowners seem more amenable to participating in snow-fence programs when they have seen the fences working in the community. Snow-fences in areas that are less traveled by the public are less able to generate these same positive public sentiments.

Program age also influences community recognition. For example, Wyoming's program has been around for several decades and many local landowners already know that it exists and have seen how it benefits local roadways. In contrast, Iowa's DOT maintenance crew report that initially gaining participation for the state's cornrow program in new communities requires "a lot of leg-work." However, once a few open-minded farmers participate in the program, neighbors see that the snow fencing is effective and are more willing to participate themselves. As IDOT staff explained: "once you get momentum the program sells itself". Other states also reported people calling to complain in years that temporary snow-fences were not installed in areas they had been in the past.

IX. Winter Conditions

Abundant snow encourages landowners to utilize snow-fences. Programs have reported that participation is often based upon snowfall in the previous year. Mild winters typically cause landowners to forget about the need for snow-fences. Similarly, people tend to have more interest in the fences after years of heavy snowfall. In states with frequent severe winters or on roads with bad snowdrift

problems landowners are typically more aware of the problem and more amenable to participating in solutions.

X. Excellent Maintenance

Maintenance is essential for effective programs; especially for LSFs. Maintenance ensures the survivability of LSF plantings and demonstrates to the public that the fences are well managed, and the program is reputable. When LSFs are establishing they are especially susceptible to invasive species, deer, wildfires, insect pests, harsh weather etc. and require extra maintenance. Without proper maintenance, many LSFs do not survive. In Wyoming, conservation districts do all maintenance until the plantings are established. Other programs guarantee survivability of trees in the first year after planting. While extra maintenance involves more financial and time commitment early in the program, it helps ensure the success of LSF plantings.

3.3.2.2 Common Challenges/Obstacles

I. Landowner Inconvenience

The largest obstacle to snow-fence adoption faced by snow-fence programs is the inconvenience that the fences cause to landowners in terms of increased time or reduced production in their farming practices. This inconvenience occurs in two ways:

- Permanent structural or living snow-fences take land out of production causing landowners to lose potential income. This is especially a barrier in years when crop prices are high. During these years, landowners will use every square foot they can on their property or else they are losing money.
- The fences require additional efforts on the part of landowners when they are planting and cultivating crops. Modern farming equipment is so large that it takes more time and effort to navigate around snow-fences. Landowners often must alter herbicide-spraying patterns to avoid killing LSFs, which poses an inconvenience. In some cases, even temporary fences can affect field moisture in the spring, which negatively affects crops and makes landowners unwilling to allow fencing on their property. While corn row fence attempt to address the problem of taking valuable land out of production, bringing out or re-renting combines to process a small stretch of corn in the spring prior to planting costs landowners' time and money. The hassle involved with combining a small stretch of corn in the spring can detour landowners from participating in the program.

The more the snow-fence placement conflicts with existing practices, the less likely landowners are to allow them on their property. Several states have found that larger-scale landowners and absentee landowners are the least likely to take advantage of the cornrow programs due to this hassle.

II. Poor Relationships with Implementing Agency

Several states also cited poor relationships between landowners and the agency implementing the snow-fence programs as a major obstacle to participation. In some states, this poor relationship seemed to stem from general mistrust of the government making landowners unwilling to talk to representatives. Another DOT representative explained that the relationship between the state DOT and landowners was not always positive due to poor experiences in the past such as right-of-way disputes. These poor relationships affect the ability of the DOT to reach out to landowners and is a reason why several states collaborate with local agencies such as conservation districts for outreach.

III. Fluctuations in DOT interest

Fluctuations in DOT interest and support can be an obstacle to snow-fence program implementation. Several states mentioned that there are big differences in the snow-fence program from year to year, as support for snow-fences grows and wanes within the department and funding changes accordingly. Most states (except for Wyoming and Iowa) do not currently have specific budgets set aside for snow-fences but rather funding for snow-fences come out of normal operational budgets. Even if DOT staff recognize that snow-fences are a good idea, local preferences will dictate how snow-fences are prioritized compared to other forms of snow-control.

IV. Intimidating Contracts

Some landowners fear the liability that comes along with a snow-fence program's contract. They hesitate to sign the contract because they fear they would be liable if someone got hurt on their property or if the fence is damaged. In states with long inflexible contracts, landowners can balk against participating in something that they see as being overly bureaucratic or having strings attached. For example, Wyoming has a 30-year contract for its LSF program, which, aside from discouraging some landowners, has also caused problems due to property ownership changes over time.

3.3.2.3 Opportunities

I. New research

Continuous new research on fence design and landowner adoption can provide new opportunities to improve program implementation. For example, an issue that surfaced during SUNY ESF's research is the need to go off the right of way for living snow-fence or permanent structures may diminish. The research found the setbacks of living snow-fences or permanent structures may not need to be as long as recommended in previous research (Heavey, 2015). This may allow more work to occur on the public right of way and not on private property.

II. Value Added Products

Another solution is value added products. This has been proposed but most states have just committed research. In Minnesota, research has identified tree species that can produce potential alternative products that can also be used as snow-fences (Streed & Walton, 2001) and is conducting studies with species with potential for biomass production. In New York, species with biomass or pollinator values have been investigated. For LSFs, there may also be markets for payments for ecosystem services in the future.

III. Staff Training

Staff preferences for using snow fencing compared to other winter maintenance techniques are often related to familiarity with snow fencing as a tool. In New York, the state has provided the staff with several rounds of training that helped to ensure that all NYSDOT employees are aware of snow-fences and how to design and install them. More information about the NYSDOT training can be found in the appendix. MnDOT, in collaboration with University of Minnesota, is also conducting a project to reduce blowing-and-drifting snow and associated costs through and effective outreach program to MnDOT staff and through them, to landowners. The objectives of the project are to carry out a pre-promotion KAP (Knowledge, attitudes, and practices) survey, design a training to promote installation of snow-fences and the associated cost savings based on the KAP study, implement the training, carry out a post-training KAP study, and assess the market and non-market value of different permanent and non-permanent snow-fence designs.

IV. New Collaborations

Many programs report that working with local natural resource professionals and soil conservation technicians has been key to the success of their programs. It is helpful to collaborate with local technicians because landowners trust local technicians and listen to their suggestions. Another DOT was planning to reach out to local law enforcement, fire departments, and emergency responders to help promote snow-fence programs. Landowners may be more willing to listen to local safety officials about the safety benefits of snow-fences. Many states also report that sharing information and attending meetings with other states is effective as states can learn from one another's programs.

V. Promotion

Many states suggest expanding outreach to the public to promote a general understanding of what snow-fences are and how they benefit the local environment and community. This can significantly improve public understanding and awareness of snow-fence programs that helps promote landowner adoption. As one snow-fence program representative explained, public outreach explaining snow-fences helps the public understand the actions of DOTs and trust that these agencies are being good stewards of taxpayer dollars.

Suggestions for improved outreach can include:

- Distributing pamphlets on the useful qualities of snow-fences in local communities and in schools
- Using snow-fences as “demo projects” to promote and test new technologies
- Employing of webinars and seminars to train people in the local community
- Promoting benefits of snow-fences aside from snow-control such as wildlife habitat, aesthetics, noise barriers (trees), protection from wind, etc.
- Encouraging word-of-mouth promotion between landowners. The more landowners understand benefits and communicate them to others the better (Williamson & Volk, 2009).

3.4 CONCLUSIONS: THE FUTURE OF SNOW-FENCE OUTREACH

This report summarizes the current state of snow-fence utilization in the United States as well as common characteristics of strong snow-fence programs and barriers to snow-fence program adoption. The information and suggestions in this report were compiled based upon a review of existing scientific literature as well as conversations with experts working in the field to implement snow-fence programs. While these suggestions focus upon snow-fences, many of the ideas found in this report may also be helpful when addressing other challenges related to landowner adoption of safer more sustainable technologies. The goal of this research is to provide a useful background of current snow-fence use in the United States and act as a resource for the continuous improvement of programs interested in landowner outreach.

CHAPTER 4: PROMOTIONAL AND EDUCATIONAL CAMPAIGN DESIGNED FOR MNDOT STAFF. TESTING EDUCATIONAL APPROACHES

4.1 INTRODUCTION

This task is an integral part of this project taking what was learned in the TAP exercise and the review of snow-fence programs across the country and, based on that: 1) providing training to MnDOT Maintenance Staff and Engineers; 2) developing educational and promotional materials; and 3) designing a promotional and educational campaign for MnDOT personnel, farmers and landowners, and communities in District 8 impacted by blowing-and-drifting snow. This report presents a summary of the process that was used, the promotional, educational and logistical material developed for maintenance personnel, farmers and the public and the promotional materials developed for promoting standing cornrows in 2016-17. The materials were developed in a way that would allow them to be used by other MnDOT Districts with minor modifications. Many of these materials are already being used and will be used in the fall of 2016 to promote standing cornrows. This will allow us to evaluate the tools and make changes as needed. (See materials in Appendix F)

Our snow-fence team determined that in order for the MnDOT snow-fence program to run more efficiently, check lists should be created to help MnDOT staff at all levels complete their tasks. That has been in important part of our work in Task 3 preparing the checklists and vetting them with the maintenance staff that will be using them, office staff in the business office that are responsible for paper work and payments to landowners and supervisors who are responsible for the snow-control programs

District 8, Willmar, MN is our pilot district to work with and train. All other MnDOT districts in the state will use traditional outreach methods to promote the MnDOT snow-fence program such as news releases and landowners working with County Soil and Water Conservation Districts (SWCD), USDA Farm Service Agency and Natural Resources Conservation Service staff. This group will be our “control” group to compare the trained efforts of District 8 staff.

This task, as in all of our tasks has required and benefitted from the close collaboration of MnDOT staff in District 8. Starting with the initial KAP process that included meetings and surveys to determine research needs, through to the development of the checklists and promotional materials and educational campaign of this task, the work has involved numerous meetings with District 8 maintenance staff and supervisors, the business office, and the public affairs office. A special thanks to Dan Gullickson for his dedication and assistance with all aspects of this project, Farideh Amiri for her support, Craig Gertsema and Shannon Wait for helping to organize meetings and sharing their expertise, Mandi Lighthizer who was instrumental in providing input for, designing and preparing the promotional and educational plan for landowners/farmers and the local communities, and Ione Pillard who helped

guide us through the landowner/farmer payment plan. The project is strengthened by the active participation of MnDOT staff who have been engaged throughout.

This report includes information on the training workshops, materials developed for the workshop which have become part of the promotional and educational plan, workshop evaluations and notes on follow-up meetings with maintenance staff to report back and plan for the fall standing corn rows campaign.

4.2 PROMOTIONAL MATERIALS

Checklists and resources were developed to help make the process easier for MnDOT staff to implement at all stages of snow-fence enrollment.

Check lists:

Snow-fence Advocate: Meet the Farmer

Snow-fence Advocate: Payment Process

Working with USDA and SWCD

Non-Permanent Snow-fence Sign-Up Procedure

Input Sheets for Tools on the www.snowcontroltools.umn.edu web site:

Input Sheet for the Cost – Benefit Tool
Input Sheet for the Snow-fence Design
Tool

4.3 MNDOT TRAINING AND WORKSHOPS

Training Workshops in District 8 with Maintenance and Program Delivery Staff:

We held two training workshops in District 8 in Willmar. May 17 was the Maintenance staff training which totaled 19 of which were five accounting staff who process the landowner payments. The remaining 14 MnDOT employees were plow drivers and maintenance staff. May 18 was the Program Delivery staff training, which totaled four. (There was a delay in the email invitation that could have attributed to the low attendance)

4.3.1 Training Agendas for Maintenance and Program Delivery MnDOT Staff in District 8, Willmar, MN

Maintenance – Agenda (May 17):

- Science and Practice of Snow-fences (Types of Snow-fences)
- Climate – Snow-fence - Design Tool (Using climate data to figure fence placement)
- Engaging Farmers/Landowner and Partners in Snow-fence Practices
- Working with Partners to establish Snow-fences
  (SWCD, NRCS, FSA, other organizations)
- How to sign up for the Cost/Benefit Tool
- Where do we go from here? Discussion …. Evaluation

Program Delivery – Agenda (May 18):

- Science and Practice of Implementing Blowing-snow-control Measures
- How to Access Minnesota's Winter Climate Database for Road and Snow-fence Design
- MnDOT's Snow Trap Inventory –Where to find MnDOT's blowing-snow problem areas
- Understanding the P6 Blowing-snow-control Work Package
- Snow-control through Road Design- Use of Typical Illustrations including tools for determining the prevailing winter wind attack angle
- Use of GEOPAK Snow Drift Analytical Tool
- Assessing the Cost Effectiveness of Blowing-snow-control Measures (Cost/Benefit Tool)
- Engaging Farmers/Landowners and Partners to Install Blowing-snow-control Practices
- Review, Next Steps, Evaluation, and Training Certificate Awards

4.3.2 Pre-and Post-Workshop Evaluations

4.3.2.1 Maintenance Staff

Attendance: 16 attended
Date: Tuesday, May 17, 2016
Location: Willmar

Questions
Possible responses: Strongly Disagree, Disagree, Somewhat Disagree, Somewhat Agree, Agree, Strongly Agree

I have a deeper understanding of the subject matter because of this meeting. (100% responded to Agree or Strongly Agree)

I have situations in which I can use what I have learned in this meeting. (85% responded to Agree or Strongly Agree)

I will change my practices based on what I learned from this meeting. (86% responded to Agree or Strongly Agree)

(Possible responses: Very Little, Little, Some, Much, Very Much)

Results

1. Science and Practice of Implementing Blowing-snow-control Measures
Before the program: 29% responded very little or little and 14% responded much or very much After the program: 0% responded very little or little and 100% responded much or very much. This is an 86% increase in knowledge.

2. How to Access Minnesota's Winter Climate Database for Road and Snow-fence Design Before the program: 79% responded very little or little and 7% responded much or very much after the program: 0% responded very little or little and 86% responded much or very much. This is a 79% increase in knowledge.

3. MnDOT's Snow Trap Inventory – Where to find MnDOT's blowing-snow problem areas before the program: 71% responded very little or little and 14% responded much or very much after the program: 0% responded very little or little and 86% responded much or very much. This is a 72% increase in knowledge.

4. Engaging Farmers/Landowners and Partners to Install Blowing-snow-control Practices (Including Payment/Structure Checklist).
Before the program: 64% responded very little or little and 14% responded much or very much After the program: 0% responded very little or little and 64% responded much or very much. This is a 50% increase in knowledge.

5. Working with Partners to Establish Snow-fences (SWCD, NRCS, FSA, other organizations) before the program: 86% responded very little or little and 7% responded much or very much after the program: 0% responded very little or little and 71% responded much or very much. This is a 64% increase in knowledge.

6. Assessing the Cost Effectiveness of Blowing-snow-control Measures (Cost/Benefit Tool) before the program: 79% responded very little or little and 7% responded much or very much after the program: 0% responded very little or little and 71% responded much or very much. This is a 64% increase in knowledge.

Comments: (Maintenance Staff)

- Good information for future use
- Very informative; laid out well, motivational to want to get more involved
- This was great. A lot of info in a short time and everyone did a good job. I learned a lot. Thank you.
- Very good info today. I think this will help us greatly.
- A lot of training at once, but learned a lot of good information. Now know where to begin I have a problem with blowing-snow.
- Great content and presentation from all presenters. Great lunch and networking. Expect great strides in getting form OPRs to sign up

4.3.2.2 Program Delivery Staff

Attendance: Four attended
Date: Wednesday, May 18, 2016
Location: Willmar, MN

Responses:

I have a deeper understanding of the subject matter because of this meeting. (100% responded to Agree or Strongly Agree)

I have situations in which I can use what I have learned in this meeting. (100% responded to Agree or Strongly Agree)

I will change my practices based on what I learned from this meeting. (75% responded to Agree or Strongly Agree)

(Possible responses: Very Little, Little, Some, Much, Very Much)

1. Science and Practice of Implementing Blowing-snow-control Measures
Before the program: 25% responded very little or little and 0% responded much or very much After the program: 0% responded very little or little and 100% responded much or very much. This is a 100% increase in knowledge.

2. How to Access Minnesota's Winter Climate Database for Road and Snow-fence Design Before the program: 50% responded very little or little and 0% responded much or very much after the program: 0%

responded very little or little and 75% responded much or very much. This is a 75% increase in knowledge.

3. MnDOT's Snow Trap Inventory – Where to find MnDOT's blowing-snow problem areas before the program: 75% responded very little or little and 25% responded much or very much after the program: 0% responded very little or little and 100% responded much or very much. This is a 75% increase in knowledge.

4. Understanding the P6 Blowing-snow-control Work Package
Before the program: 75% responded very little or little and 0% responded much or very much After the program: 0% responded very little or little and 50% responded much or very much. This is a 50% increase in knowledge.

5. Snow-control through Road Design – Use of Typical Illustrations including tools for determining the prevailing winter wind attack angle. Before the program: 100% responded very little or little and 0% responded much or very much After the program: 0% responded very little or little and 75% responded much or very much. This is a 75% increase in knowledge.

6. Use of GEOPAK Snow Drift Analytical Tool
Before the program: 100% responded very little or little and 0% responded much or very much After the program: 0% responded very little or little and 75% responded much or very much. This is a 75% increase in knowledge.

7. Assessing the Cost Effectiveness of Blowing-snow-control Measures (Cost/Benefit Tool) before the program: 100% responded very little or little and 0% responded much or very much after the program: 0% responded very little or little and 75% responded much or very much. This is a 75% increase in knowledge.

8. Engaging Farmers/Landowners and Partners to Install Blowing-snow-control Practices Before the program: 75% responded very little or little and 0% responded much or very much after the program: 0% responded very little or little and 75% responded much or very much. This is a 75% increase in knowledge.

Comments: (Program Delivery Staff)

- Good job!
- Address upper management with concept to get buy-in @ earlier time in the process
- Good discussion on Project Scoping
- Get Maintenance involved in Project Scoping earlier
- Look at the opportunities in 10-year plan to look for areas to do living snow-fence

4.3.3 Post Training Workshop Assignments and Promotional Material

4.3.3.1 Assignments

After the Maintenance staff training on May 17, our team determined that a good way to keep in touch with this group and to encourage them to continue to work on the snow-control tools on the web is to give them summer assignments. Three assignments were given to be done in 3 months.

1. June – Identify you to two or three problem snow sites in your area. For each of these sites run the cost- benefit and snow-fence design tool. Report your findings to Dan Gullickson, MnDOT Snow-fence Coordinator.

2. July – Meet the Soil and Water Conservation District technician in charge of living snow-fences in the County of your identified snow problem sites.

3. August – Meet together as a group and discuss the summer assignments, promotional materials, handouts, check lists and address questions before the MnDOT staff contacts farmers and landowners in August and September to protect highways this winter.

4.3.3.2 Maintenance Staff

As follow-up to the initial training workshops and assignments, we met on August 10 to follow-up on the assignments and receive input from the maintenance staff attending on the promotional plan for snow-control measures with an emphasis on the current standing cornrow sign-up. The attendees in this meeting will be the designated staff for promoting the standing cornrow sign-up. The notes from that meeting are included as Appendix E.

CHAPTER 5: SECOND-ROUND KAP REPORT

5.1 INTRODUCTION

In January 2017, we conducted a second-round KAP survey with MnDOT employees. In total the second-round survey included 36 questions including all of the questions that were included in the first KAP survey as well as additional questions about whether survey participants attended the District 8 training or participated in the round-one survey. The second-round survey also included questions regarding the use of new outreach tools made available to MnDOT employees working with landowners. Question topics were split between knowledge, attitudes, and practices.

We notified MnDOT District 8 employees of the survey via email, and they were given until January 27, 2016 to complete the survey online. Two reminder emails were sent out to all participating employees to encourage additional submissions.

The sampling frame included all MnDOT District 8 employees identified as relevant to the study, 200 individuals in total. Forty-nine individuals responded to the survey, resulting in a 25% response rate. This response rate is slightly lower than the first-round KAP survey with a 33% response rate.

The results of the second-round KAP survey are featured in this report. It is important to note that these results cannot be directly compared with the results of the first-round KAP study to infer change in knowledge, attitudes, and practices, because different individuals from MnDOT participated in each round of the survey.

5.2 RESULTS

In this section of the report, the results for each individual survey question will be summarized with respondent comments considered. All percentages are rounded to the nearest whole percent.

5.2.1 Q1: I understand that participation in this survey is voluntary and that my answers are confidential and cannot be associated with my name. I also understand that whether I participate in the survey will not affect my relationship with the Minnesota Department of Transportation or the University of Minnesota.

48 survey respondents answered this introductory question. Descriptive statistics are given in Figure 5.1 below

Answer Choices	Responses	
Yes, I understand and agree to take the survey	100.00%	48
Yes, I understand and do not want to participate in the survey	0.00%	0
Total		48

Figure 5.1 Participant Understanding Descriptive Statistics

All respondents indicated that they understood the terms of participation in the survey and agreed to participate.

5.2.2 Q2: Last December/January, MnDOT conducted an initial survey on blowing-snow-control. Did you participate in the initial survey last December/January?

49 individuals (100% of respondents) answered this question. Descriptive statistics are given in Figure 5.2 below

Answer Choices	Responses	
Yes, I filled out the survey last year	40.82%	20
No, I did not fill out the survey	30.61%	15
I don't know	28.57%	14
Total		49

Figure 5.2 Round one Survey Participation Descriptive Statistics

Responses to this question revealed that over half (59%) of survey respondents either did not fill out the first-round survey last year or did not know for sure whether or not they participated in the first-round KAP survey. These responses illustrate the reason why the results of the first-round KAP survey cannot be directly compared to the second-round KAP survey to infer change in knowledge, attitudes or practices.

5.2.3 Q3: Last May MnDOT conducted a training in conjunction with the University of Minnesota about Snow-fences and Blowing-snow-control in Wilmar. Did you attend this training?

49 individuals (100% of respondents) answered this question. Descriptive statistics are given in Figure 5.3 below.

Answer Choices	Responses	
Yes, I attended this training	**34.69%**	17
No, I did not attend this training	**63.27%**	31
I don't know	**2.04%**	1
Total		49

Figure 5.3 Workshop Participation Descriptive Statistics

Responses to this question revealed that over half (65%) of survey respondents either did not attend the training or did not know for sure whether or not they attended the training. 17 people (or 35% of participants) reported that they did attend the training. From training records, we know that 23 individuals attended the trainings in May. This means that of the 23 people who attended the training, 74% filled out the survey. Because MnDOT employees who attended the training may now hold different knowledge, attitudes, and practices related to snow-fences, compared to employees that did not attend the training, many of the following questions in this survey are analyzed using cross-tabulations that distinguished between the answers of training participants and non-participants.

5.2.4 Q4: What is your job type?

48 individuals answered this demographic question; two skipped it. Descriptive statistics are given in Figure 5.4 below.

Answer Choices	Responses	
Maintenance operations	**47.92%**	23
Program delivery	**52.08%**	25
Total		48

Figure 5.4 Job Type Descriptive Statistics

Responses to this question revealed that over half (52%) of survey respondents work in MnDOT's Program Delivery while a little less than half (47%) of respondents work in maintenance operations.

5.2.5 Q5: How far removed from farming are you?

49 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.5 below.

Answer Choices	Responses
I'm active in farming	32.65% (*n*=16)
I'm not actively farming but my parents farm or were farmers	30.61% (*n*=15)
My grandparents farmed but neither my parents nor I farm today	20.41% (*n*=10)
My family has never farmed	12.24% (*n-6)*
Other	4.08% (*n*=2)
Total Respondents: 49	

Figure 5.5 Farming Experience Descriptive Statistics

Most (33%) survey respondents most frequently reported that they are currently active in farming or farmed in the past. Some elaborated that they only work in farming rather than owning their own operations. Another 31% of participants reported that their parents farm or were farmers and 20% of participants reported that their grandparents farmed. Only 12% reported that their family has never farmed. A few others pointed out that they were familiar with farming for other reasons despite not having actually farmed. For example, one respondent mentioned that they have worked processing payments for landowners at MnDOT for many years and another respondent worked in an agricultural related field prior to working for MnDOT.

5.2.6 Q6: If you farm, please check the box that applies the most.

37 individuals answered this question; the rest skipped it. Descriptive statistics are given in Figure 5.6 below.

Answer Choices		Responses	
I farm my own land		18.92%	7
I no longer farm my own land		5.41%	2
I rent my land to others		16.22%	6
I rent land from others for farming		13.51%	5
Don't know		0.00%	0
N/A		45.95%	17
Other (please specify)	Responses	16.22%	6
Total Respondents: 37			

Figure 5.6 Farming Practices Descriptive Statistics

The majority of respondents (46%) reported that this question does not apply to them. As Figure 5.5 demonstrated, only 33% of respondents are currently active in farming. This explains the high percentage of respondents that report that this question does not apply to them. The remaining respondents most commonly reported that they farm their own land (19%), rent their land to others (16%), or rent land from others to farm (14%). Only two respondents reported that they no longer farm their own land. Other respondents (those who marked other) said that they worked as hired hands on property owned by someone else (either family members or other community members). One participant also considered MnDOT work to involve farming.

5.2.7 Q7: What are the current temporary measures used by MnDOT to control blowing-snow?

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.7 below.

Answer Choices	Responses
Standing corn rows	95.83% 46
Stacked corn or hay bales	70.83% 34
Temporary snow fences (4 foot tall orange snow fence, either plastic or wood lathe corn cribbing)	85.42% 41
Mechanically wind-rowing snow in the farm field	50.00% 24
Don't know	0.00% 0
Other (please specify) Responses	6.25% 3
Total Respondents: 48	

Figure 5.7 Temporary Measures Utilized by MnDOT Descriptive Statistics

The majority of respondents (96%) report that MnDOT utilizes standing cornrows as temporary snow-control measures. The next most commonly identified measures included temporary snow-fences (85%) and stacked corn or hay bales (71%). 50% of respondents identified mechanically wind-rowing snow as a measure used by MnDOT. None of the respondents reported that they did not know of any temporary measures utilized by MnDOT. In addition, one respondent reported that MnDOT uses other temporary measures such as growing sudan grass and other cover crops. Figure 5.8 provides cross-tabulated data (workshop attendance x recognition of temporary measures currently utilized by MnDOT) and shows that in general staff that report that they attended the training were more likely to identify each temporary measure currently utilized by MnDOT compared to survey participants that did not attend the training.

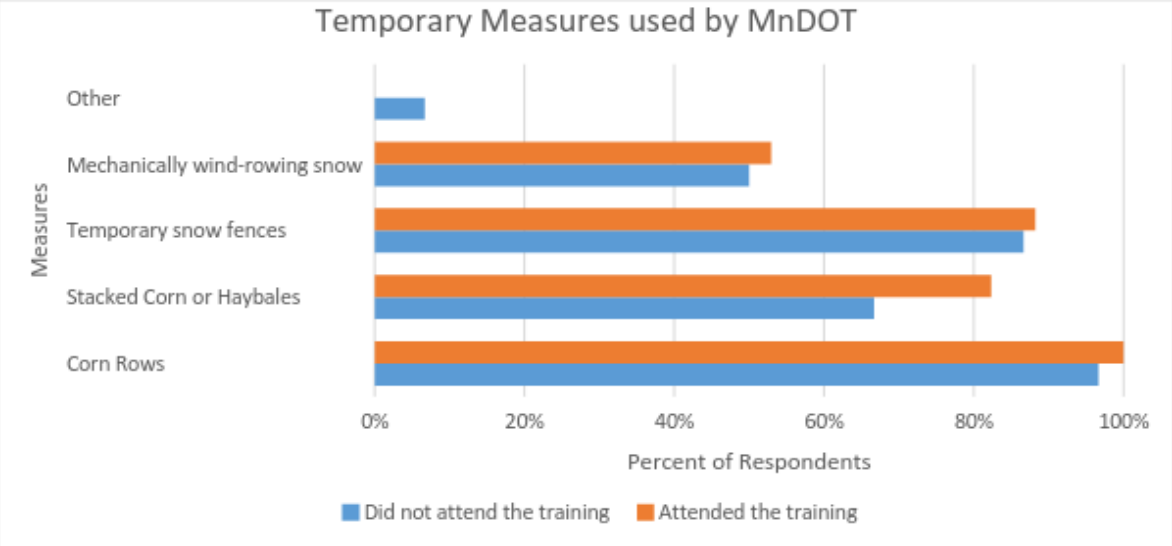


Figure 5.8 Temporary Measures Currently Utilized by MnDOT Crosstabs

5.2.8 Q8: What are the current permanent blowing-snow-control options used by MnDOT?

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.9 below.

Answer Choices		Responses	
Living snow fences		89.58%	43
Structural snow fence (wood or flexible composite rail)		60.42%	29
Earthwork (raising the road grade or flattening the back slopes)		75.00%	36
Don't know		4.17%	2
Other (please specify)	Responses	4.17%	2
Total Respondents: 48			

Figure 5.9 Permanent Snow-control Options Currently Utilized Descriptive Statistics

The majority of respondents (90%) report that living snow-fences are used for permanent snow-control. The second most commonly cited method of permanent snow-control was earthwork (75%) followed by structural snow fencing (60%). Only 4% of respondents reported that they did not know of any permanent snow-control options currently being utilized. Figure 6.10 provides cross-tabulated data (workshop attendance x permanent snow-control measures currently utilized by MnDOT) and shows that MnDOT employees that that attended and did not attend the training seemed to have similar knowledge of permanent snow-control measures. However, relatively more people who had attended the training recognized the permanent snow-control measures compared to individuals who had not attended the training.

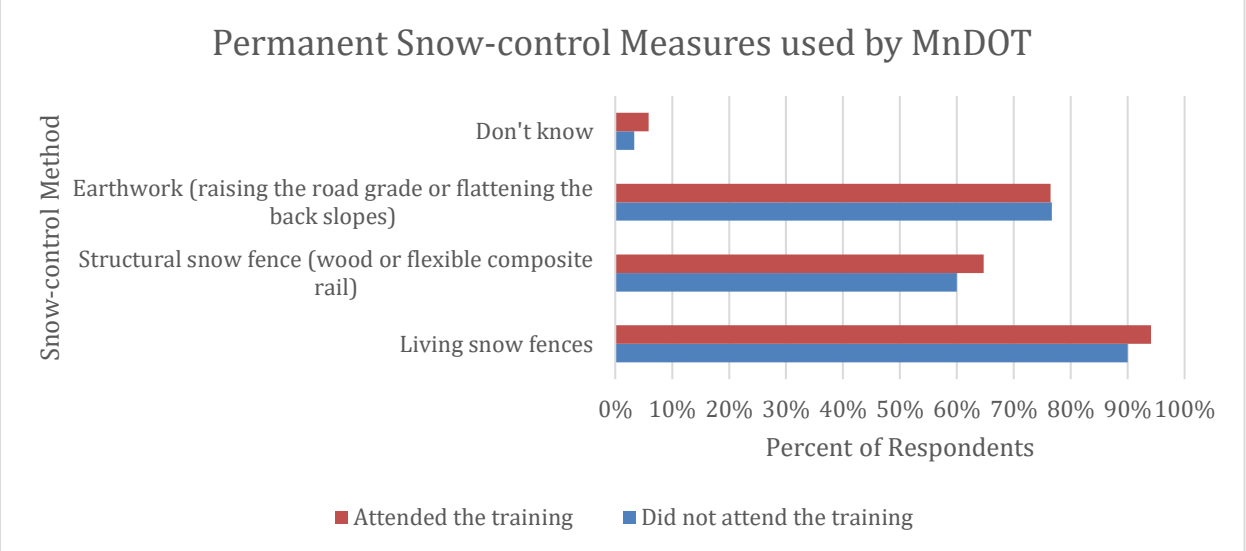


Figure 5.10 Permanent Measures Currently Utilized Crosstabs

5.2.9 Q9: Please indicate your familiarity with the following blowing-snow-control practices.

49 individuals answered this question; none skipped it. Descriptive statistics are given in Figure 5.11 below.

	I have actually worked with landowners to implement this practice	I have seen this practice but have not used it myself	I am not aware of this practice	Total
Standing corn rows	20.83% 10	79.17% 38	0.00% 0	48
Stacked corn or hay bales	10.20% 5	79.59% 39	10.20% 5	49
Living snow fences using hybrid willows	6.25% 3	77.08% 37	16.67% 8	48
Living snow fences using traditional species such as Dogwood	10.42% 5	77.08% 37	12.50% 6	48
Temporary snow fences (4 foot tall orange fences)	18.37% 9	77.55% 38	4.08% 2	49
Permanent structural snow fence	12.50% 6	68.75% 33	18.75% 9	48
Earthwork (raising the road grade or flattening the back slope)	19.57% 9	69.57% 32	10.87% 5	46
Mechanically wind rowing snow in farm fields	21.28% 10	51.06% 24	27.66% 13	47

Figure 5.11 Familiarity with Blowing-snow-control Practices Descriptive Statistics

Figure 5.11 shows that the majority (between 51%-80%) of MnDOT employees are aware of the different practices that exist but have not actually worked with landowners to implement any of the listed practices. The most frequently used practice was windrowing snow in fields (21% of respondents had used it). However, at the same time this was the least frequently recognized practice.

No more than a third (33%) of MnDOT employees indicated that they were *not* familiar with any of the practices listed. 100% of survey respondents either have seen (79%) or used (21%) standing cornrows. The most commonly used snow-fence practices include mechanical windrowing (21%), cornrows (21%) and earthwork (20%). In total, MnDOT employees were most likely to report that they have seen the different snow-control practices rather than having used them.

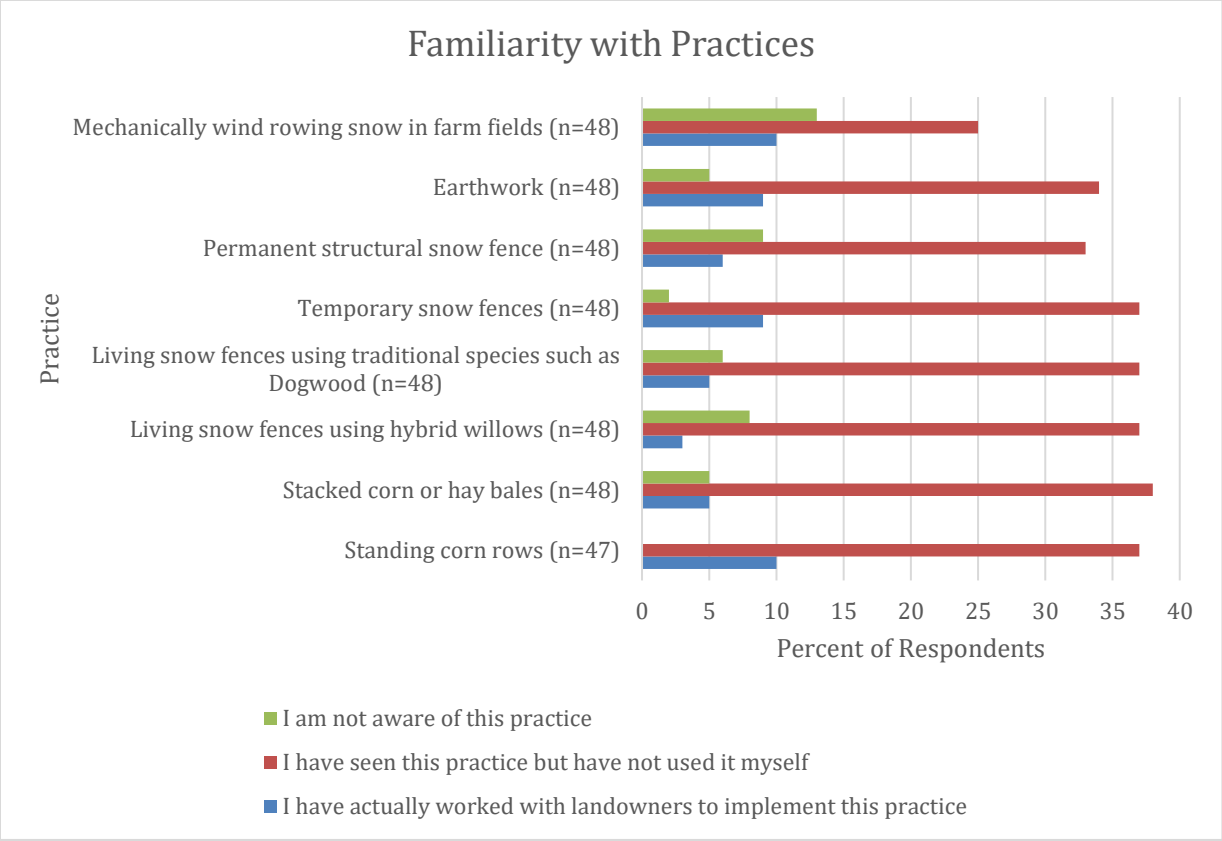
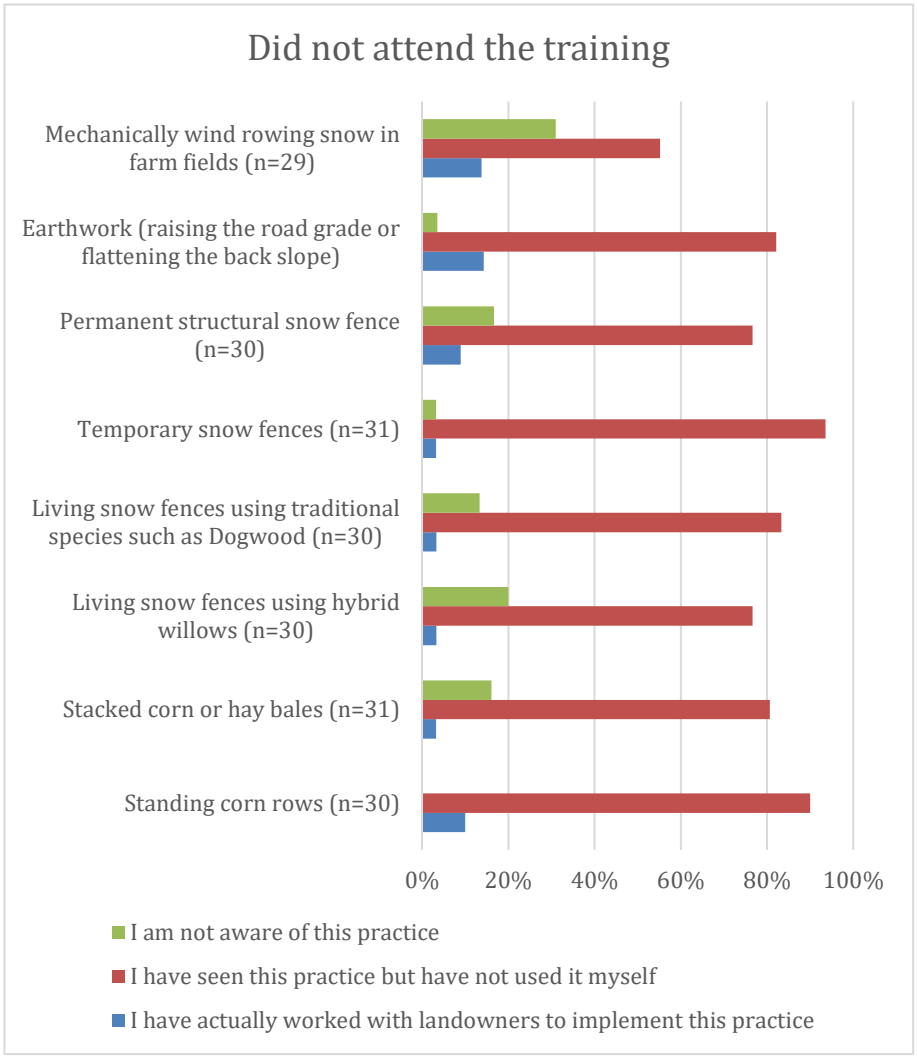


Figure 5.12 Familiarity with Blowing-snow-control Practices Bar Chart

Figure 5.13 provides a side-by-side comparison of familiarity with different blowing-snow-control practices between workshop attendees and non-attendees. The comparison shows that workshop attendees were vastly more likely to have used the various blowing-snow-control practices compared to non-attendees.



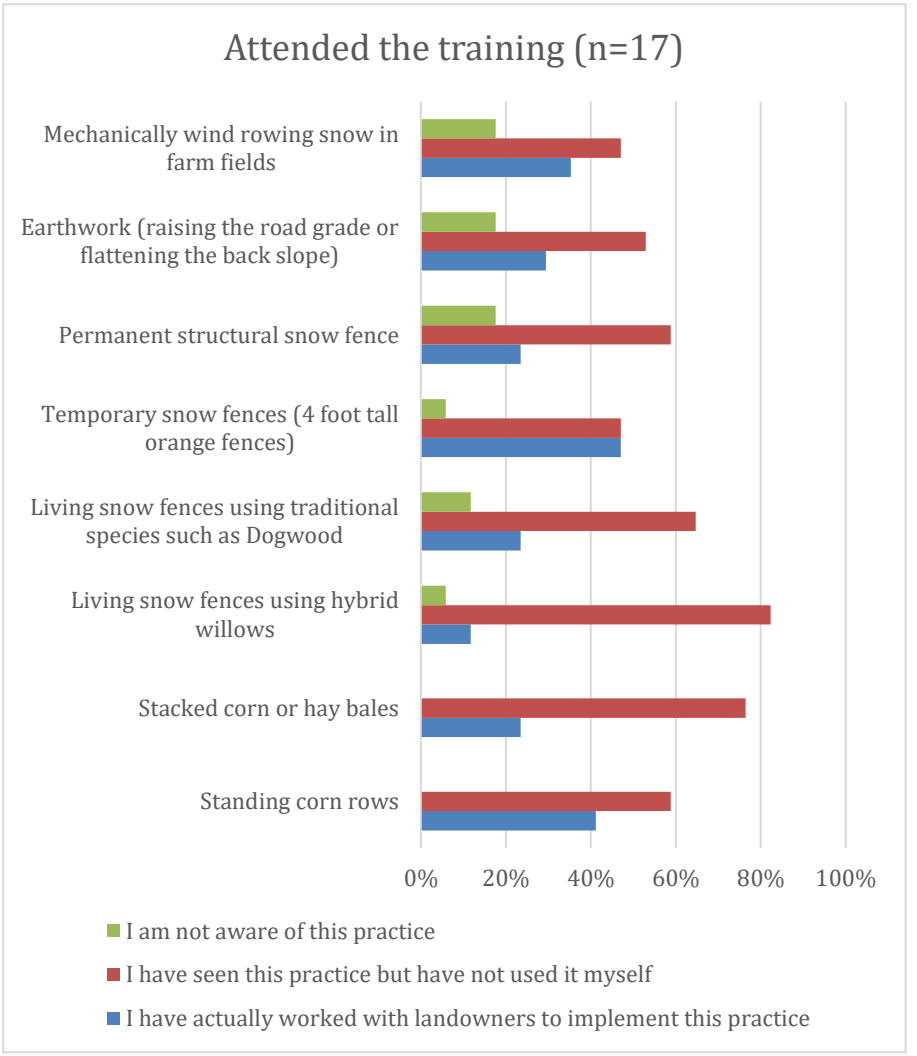


Figure 5.13 Familiarity with Blowing-snow-control Practices Side-By-Side Comparison (attended training x did not attend training)

5.2.10 Q10: Which of these practices has worked well for you?

Question 10 asked survey respondents that had experience with snow-control practices to identify which snow-control practices worked well. Forty-seven people answered the question and two people skipped it. Descriptive statistics are given in Figure 5.14 below.

Answer Choices	Responses	
Standing corn rows	51.06%	24
Stacked corn or hay bales	23.40%	11
Living snow fences using hybrid willows	12.77%	6
Living snow fences using traditional species such as Dogwood	21.28%	10
Temporary snow fence (4 foot tall orange fences)	31.91%	15
Permanent structural snow fence	19.15%	9
Earthwork (raising the road grade or flattening the back slope)	27.66%	13
Mechanically wind rowing snow in farm fields	25.53%	12
Don't know	2.13%	1
N/A	34.04%	16
Other (please specify) Responses	4.26%	2
Total Respondents: 47		

Figure 5.14 Practices that Worked Well Descriptive Statistics

51% of respondents report that standing cornrows work well. Another respondent wrote that even leaving only corn stalks in fields helps to prevent blowing ice on roads. This respondent suggested that it might even be cheaper for MnDOT to ask farmers to only leave stalks rather than entire rows.

Other commonly cited practices included earthwork (28%), temporary snow fencing (32%), mechanically wind rowing snow (26%), and stacked corn or hay bales (23%). 34% of respondents also reported that this question did not apply to them. Figure 5.15 shows these results graphically.

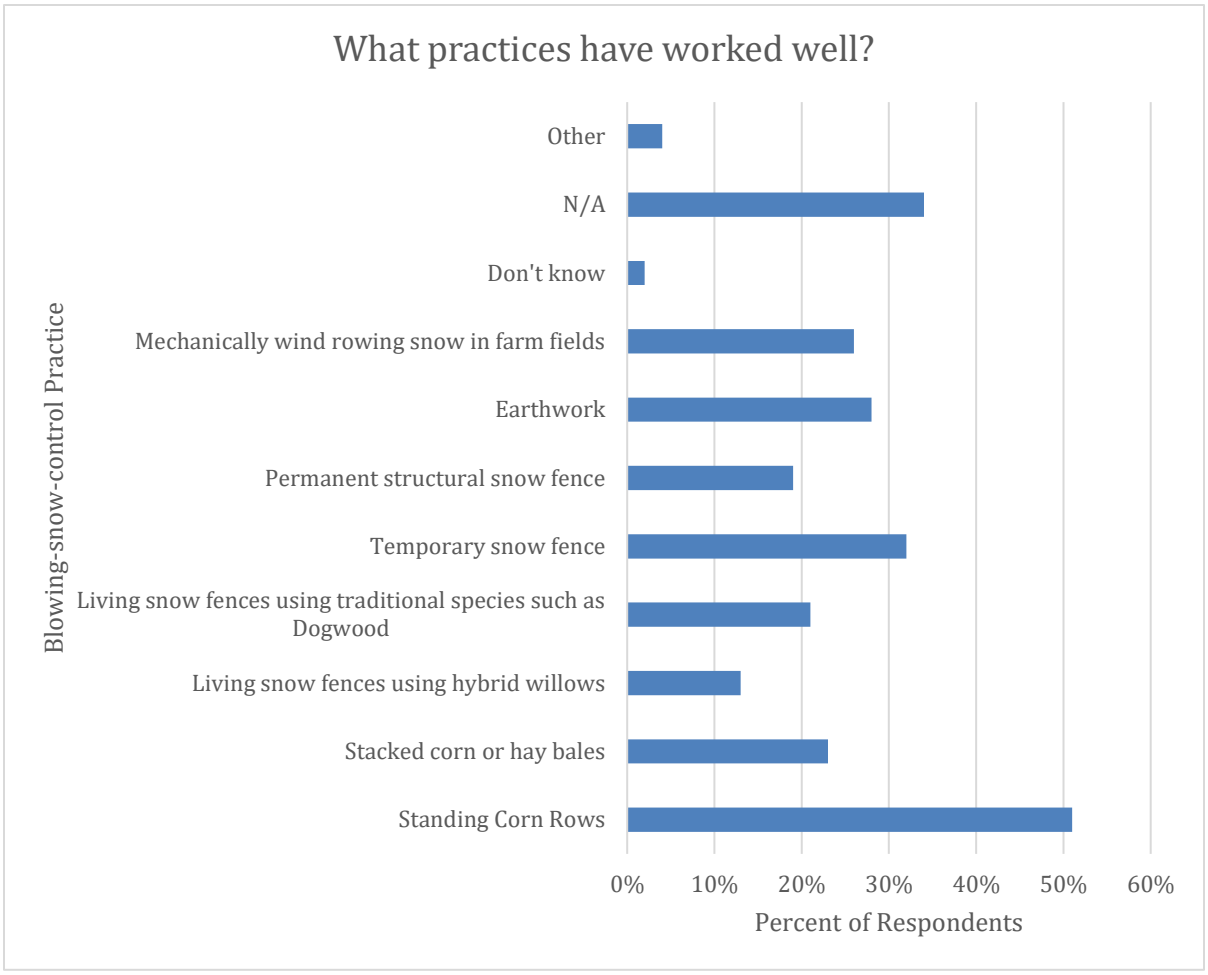


Figure 5.15 Practices that Worked Well Bar Chart

5.2.11 Q11: If a practice worked well for you, please describe where the practice was used.

44 individuals answered this question; five skipped it. Descriptive statistics are given in Figure 5.16 below.

Answer Choices		Responses	
On my own land		9.09%	4
On one of my projects		20.45%	9
Don't know		2.27%	1
N/A		43.18%	19
Other (please specify)	Responses	31.82%	14
Total Respondents: 44			

Figure 5.16 Where blowing-snow-control practices have worked Descriptive Statistics

Figure 5.16 shows that most survey respondents reported that this question did not apply to them (43%). Respondents were more likely to report that they had success with a practice on one of their projects (20%) rather than on their own land (9%). Nearly a third (32%) of the respondents marked "other." These participants reported that the measures worked well on farmland along state highways, on their plow routes, and even along their own driveways. Figure 5.17 shows these results graphically.

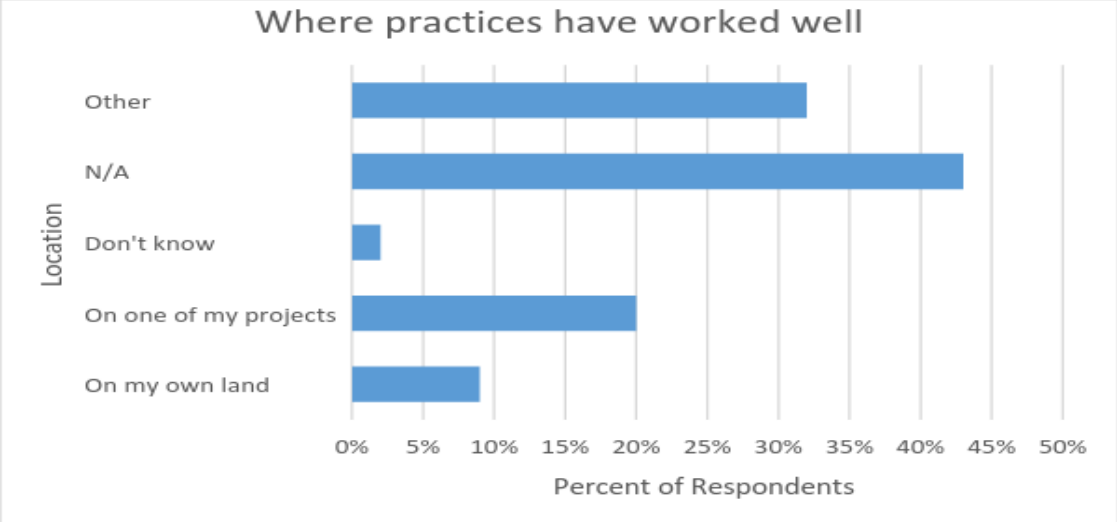


Figure 5.17 Where blowing-snow-control practices have worked Bar Graph

5.2.12 Q12: Which of these practices were well received by the landowners you have worked with?

45 individuals answered this question; five skipped it. Descriptive statistics are given in Figure 5.18 below.

Answer Choices		Responses	
Standing corn rows		37.78%	17
Stacked corn or hay bales		17.78%	8
Living snow fences using hybrid willows		8.89%	4
Living snow fences using traditional species such as Dogwood		15.56%	7
Temporary snow fence (4 foot tall orange fences)		20.00%	9
Permanent structural snow fence		11.11%	5
Earthwork (raising the road grade or flattening the back slope)		13.33%	6
Mechanically wind rowing snow in farm fields		20.00%	9
Don't know		13.33%	6
N/A		35.56%	16
Other (please specify)	Responses	4.44%	2
Total Respondents: 45			

Figure 5.18 Practices Well-Received by Landowners

Respondents most frequently reported that landowners received standing corn rows well (38%) followed by mechanically wind rowing snow in fields (20%) and temporary snow fencing (20%). One respondent also added that the landowner who installed temporary snow fencing was his/her neighbor and the fencing was installed on CRP land. The frequency that respondents identified specific practices as working well also reflects how often certain approaches are used compared to others. For example, standing cornrows were identified most often as a practice that worked well. However, in Question nine, corn rows were also one of the more commonly identified practices that people use. Figure 5.19 shows these results graphically.

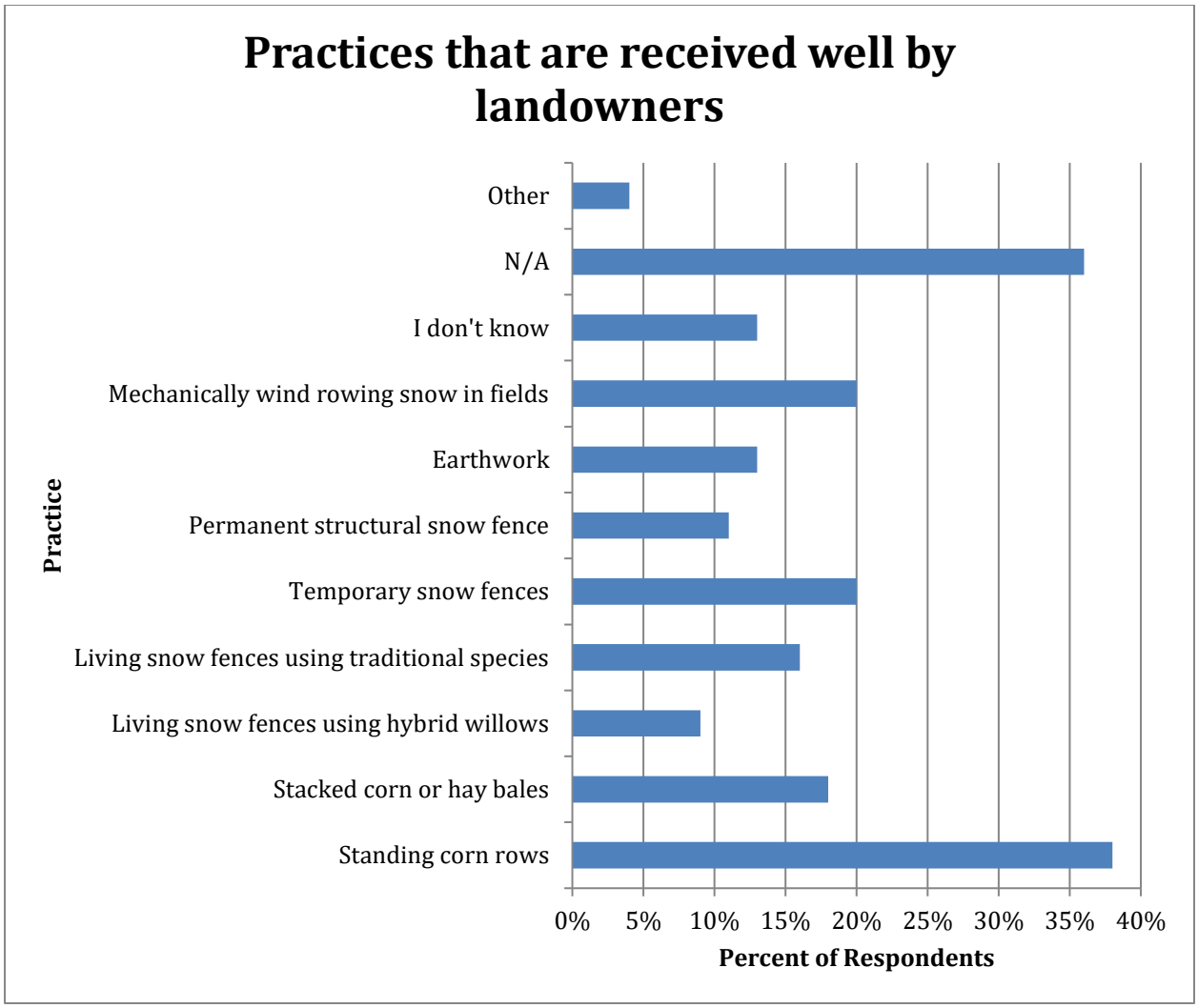


Figure 5.19 Practices that are well received by landowners Bar Graph

5.2.13 Q13. Please indicate your level of familiarity with the following blowing-snow-control tools.

47 individuals answered this question; two skipped it. Descriptive statistics are in Figure 5.20 below.

	I have actually used this tool	I have seen this tool used but have not used it myself	I am not aware of this tool	Total	Weighted Average
Minnesota Winter Climate Design Tool	11.11% 5	26.67% 12	62.22% 28	45	2.51
Benefit cost tool	13.04% 6	32.61% 15	54.35% 25	46	2.41
Highway Development Process - Blowing and Drifting Snow Control	6.82% 3	36.36% 16	56.82% 25	44	2.50
Program procedures/forms	11.36% 5	22.73% 10	65.91% 29	44	2.55
District snow trap inventory	20.00% 9	26.67% 12	53.33% 24	45	2.33
MNDOT living snow fence website	20.00% 9	40.00% 18	40.00% 18	45	2.20
CTS snow control website	9.30% 4	25.58% 11	65.12% 28	43	2.56

Figure 5.20 Level of Familiarity with Blowing-snow-control Tools Descriptive Statistics

In Figure 5.20 above, for every tool listed (except the MnDOT living snow-fence website), survey respondents most frequently indicated that they were “not aware of this tool”. The most utilized tools were the MnDOT living snow-fence website (20%) and the District snow trap (20%). Only between 6% and 13% of survey respondents reported using the other tools. No more than 40% of survey respondents reported that have even seen any of the tools. The tools that survey respondents were least aware of include program procedures/forms (66%), the CTS Snow-control Website (65% each), and the Minnesota Winter Climate Design Tool (62%). Figure 5.21 provides a side-by-side comparison of familiarity with different blowing-snow-control tools between workshop attendees and non-attendees. Figure 6.22 shows that those who attended the training were significantly more likely to have seen the tools and to have used them compared to individuals who did not attend the training. Tools were something that was reviewed in the training.

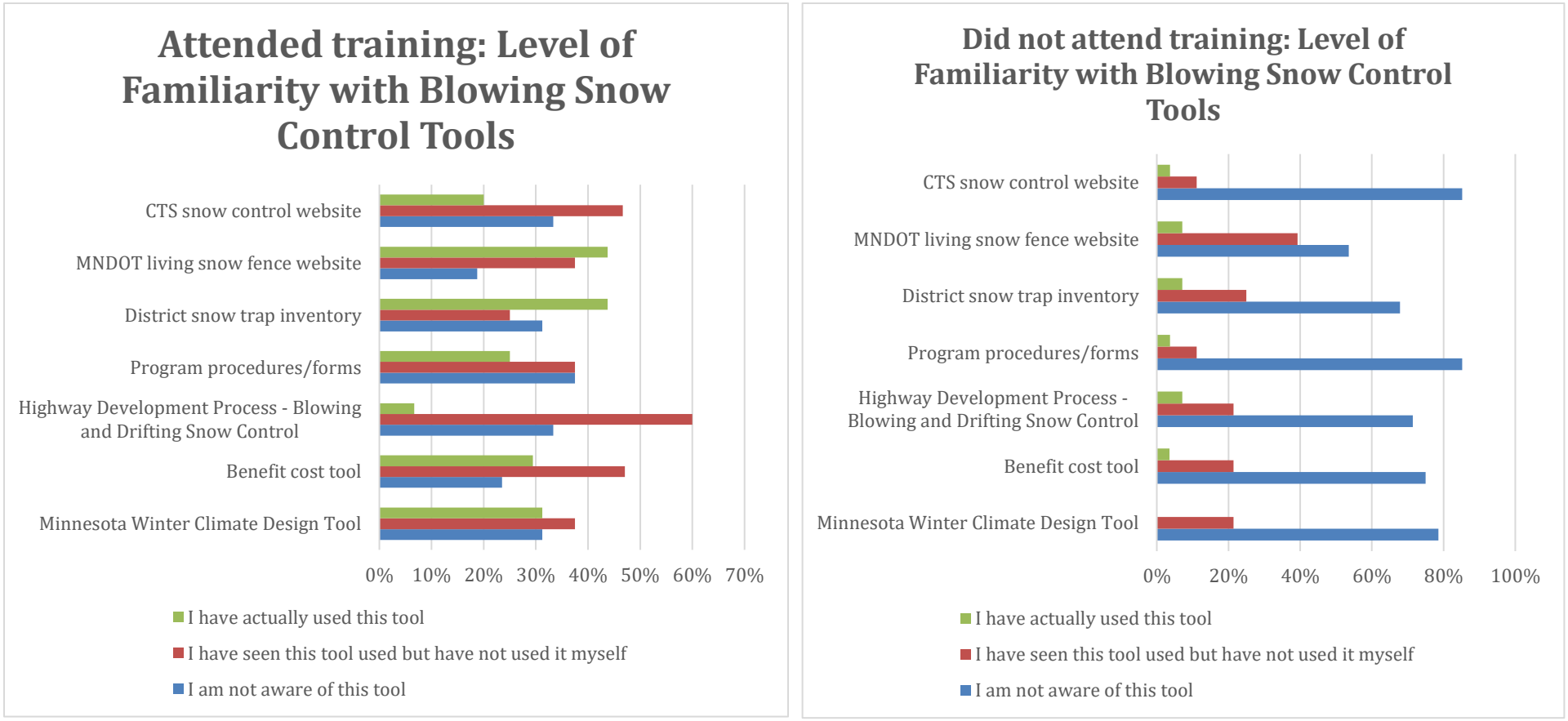


Figure 5.21 Level of Familiarity with Blowing-snow-control Tools Side-By-Side Comparison (attended training x did not attend training)

5.2.14 Q14: Who is your MnDOT District 8 living snow-fence coordinator?

36 individuals answered this open-ended question; 13 skipped it. Descriptive statistics are given in Figure 5.22 below.

Survey Responses	Responses
Craig Gertsema	64% (*n*= 23)
Incorrect Guess	5.5% (*n*=2)
I don't know	30.5% (*n*=11)
Total Respondents: 38	

Figure 5.22 MnDOT District 8 Living Snow-fence Coordinator Descriptive Statistics

64% of survey respondents were aware that the District 8 Living Snow-fence Coordinator is Craig Gertsema. The remaining respondents either guessed incorrectly or wrote that they did not know. It is also important to note that a larger number of respondents skipped this question compared to other questions. A cross tabulation showing the responses of workshop attendees vs. non-attendees is included below in Figure 5.23. As the figure shows, workshop attendees were significantly more likely to know that Craig Gertsema is the District 8 Living Snow-fence Coordinator while non-attendees were significantly more likely to report that they did not know.

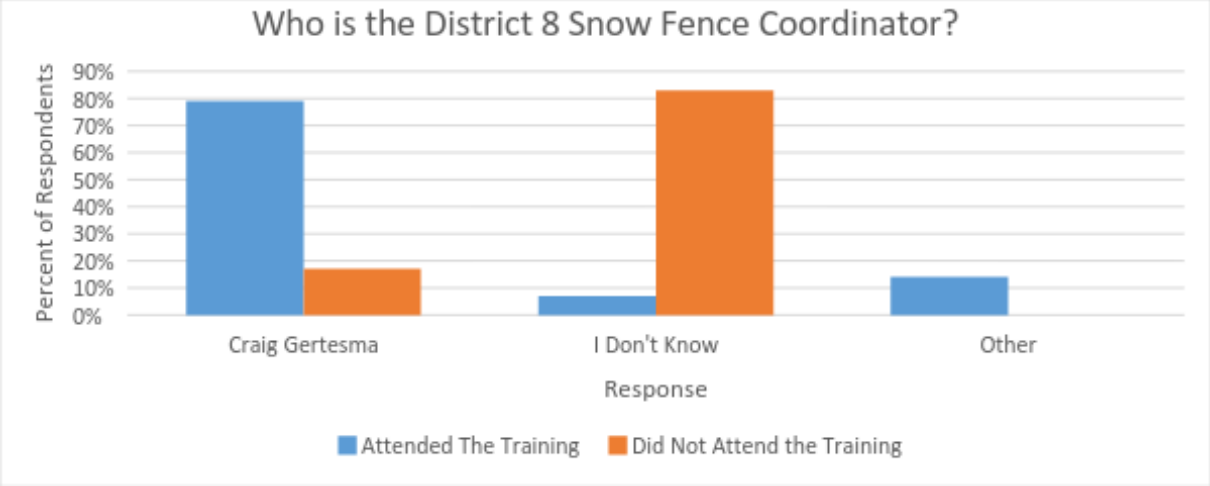


Figure 5.23 How is the District 8 Living Snow-fence Coordinator Crosstabs

5.2.15 Q15: Who is the statewide snow-fence coordinator?

32 individuals answered this open-ended question; 14 skipped it. Descriptive statistics are given in Figure 5.24 below.

Survey Responses	Responses
Dan Gullickson	56% (*n*=18)
I don't know	41% (*n*=13)
Total Respondents: 36	

Figure 5.24 Statewide Snow-fence Coordinator Descriptive Statistics

56% of survey respondents were aware that the Statewide Snow-fence Coordinator is Dan Gullickson. The remaining 41% wrote that they did not know the name of the Statewide Snow-fence Coordinator. Many other individuals skipped this question. A cross tabulation showing the responses of workshop attendees vs. non-attendees is included below in Figure 5.25. This figure shows that workshop attendees were much more likely to know who the statewide snow-fence coordinator Dan Gullickson is compared to non-attendees.

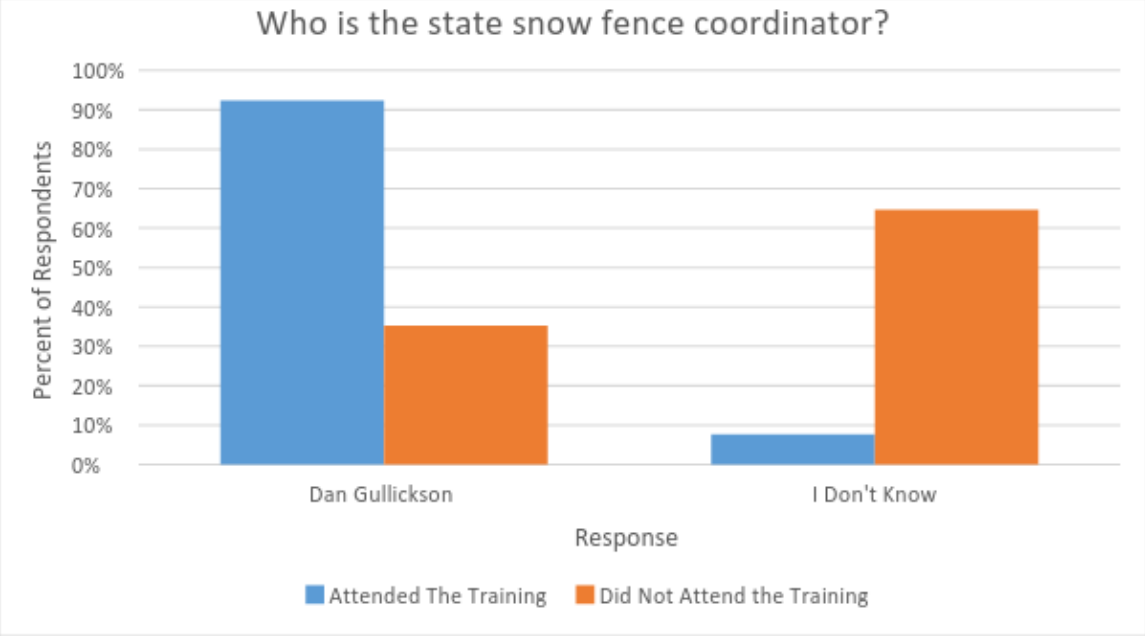


Figure 5.25 Statewide Snow-fence Coordinator Crosstabs

5.2.16 Q16: What are the best practices for implementing blowing-snow-control measures?

49 individuals answered this question; none skipped it. Descriptive statistics are given in Figure 5.26 below.

Answer Choices	Responses
Target areas identified by snow plow operators as being problematic by referring to the snow trap inventory	79.59% 39
Design a solution using the winter climate website to determine the potential snow transport	38.78% 19
Assess the blowing snow control practice cost effectiveness using the benefit cost tool	57.14% 28
Ensure that measures are acceptable to the adjacent landowner	55.10% 27
Don't know	16.33% 8
Other (please specify) Responses	6.12% 3
Total Respondents: 49	

Figure 5.26 Best Practices Descriptive Statistics

80% of survey respondents identified targeting areas identified by snowplow operators as problematic by referring to the snow trap inventory as a best practice. The second most popular best practice (57%) was to assess cost effectiveness using the benefit cost tool. The third was ensuring that measures are acceptable to the adjacent landowner (55%). 16% of survey respondents reported that they do not know any best practices. Other best practices that were suggested included reviewing crash rates and coordinating with projects that are more extensive. Figure 5.27 shows these results graphically.

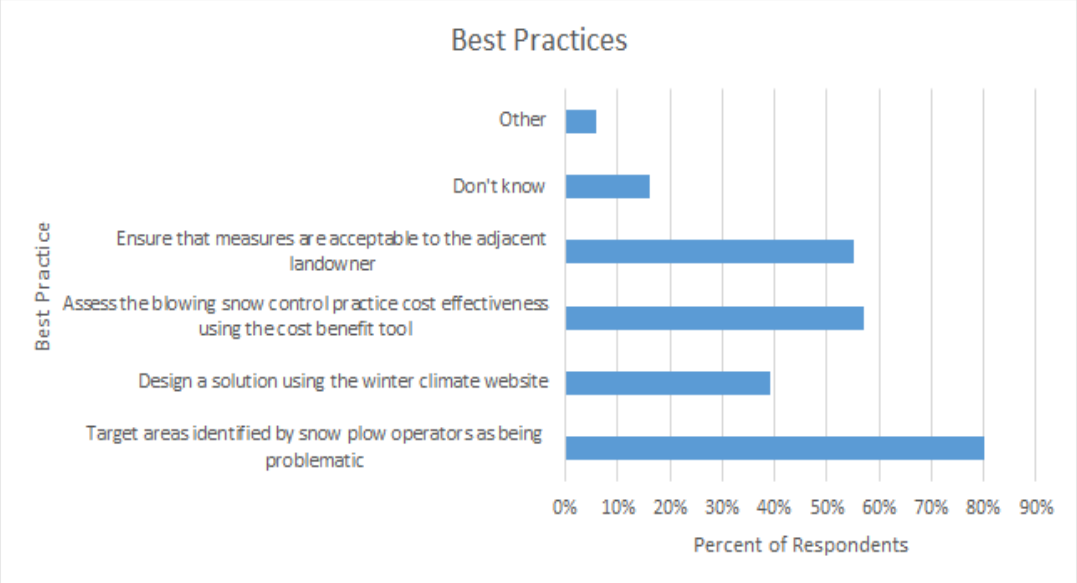


Figure 5.27 Best Practice Bar Chart

5.2.17 Q17: Please indicate your level of familiarity with the following blowing-snow-control promotional materials.

This question pertained to MnDOT staff working in maintenance operations. However, many individuals involved in program delivery also answered. 46 individuals answered this question; three skipped it. Descriptive statistics are given in Figure 5.28 below.

	I have actually used this promotional material	I have seen this promotional material but have not used it myself	I am not aware of this promotional material	N/A	Total	Weighted Average
Farmer meeting form	13.64% 6	20.45% 9	50.00% 22	15.91% 7	44	2.68
Cost benefit tool inputs	8.89% 4	26.67% 12	46.67% 21	17.78% 8	45	2.73
Post cards for farmers	6.82% 3	15.91% 7	59.09% 26	18.18% 8	44	2.89
Photos of snow control options for farmers	9.09% 4	29.55% 13	43.18% 19	18.18% 8	44	2.70
Talking points for meeting with farmers	11.11% 5	26.67% 12	44.44% 20	17.78% 8	45	2.69
Vendor registration post cards	9.09% 4	13.64% 6	59.09% 26	18.18% 8	44	2.86
Vendor registration screens for on-line sign up	6.98% 3	16.28% 7	58.14% 25	18.60% 8	43	2.88
Standing corn rows door hanger	6.82% 3	13.64% 6	59.09% 26	20.45% 9	44	2.93
Community poster	8.89% 4	20.00% 9	51.11% 23	20.00% 9	45	2.82
Business cards	18.60% 8	11.63% 5	48.84% 21	20.93% 9	43	2.72

Figure 5.28 Familiarity with Blowing-snow-control Promotional Materials

Respondents most commonly reported that they were not aware of the promotional material (44%-59%). The most commonly used material were business cards (19%), the farmer meeting form (14%), and talking points for meeting with farmers (11%). Figures 5.29 and 5.30 show results for individuals who attended the training compared to individuals that did not attend the training. It shows that people who did not attend the training were significantly more likely to report that the promotional tools did not apply to them. Similarly, individuals who had attended the training were more likely to have reported that they were either aware of, or had used the promotional tools.

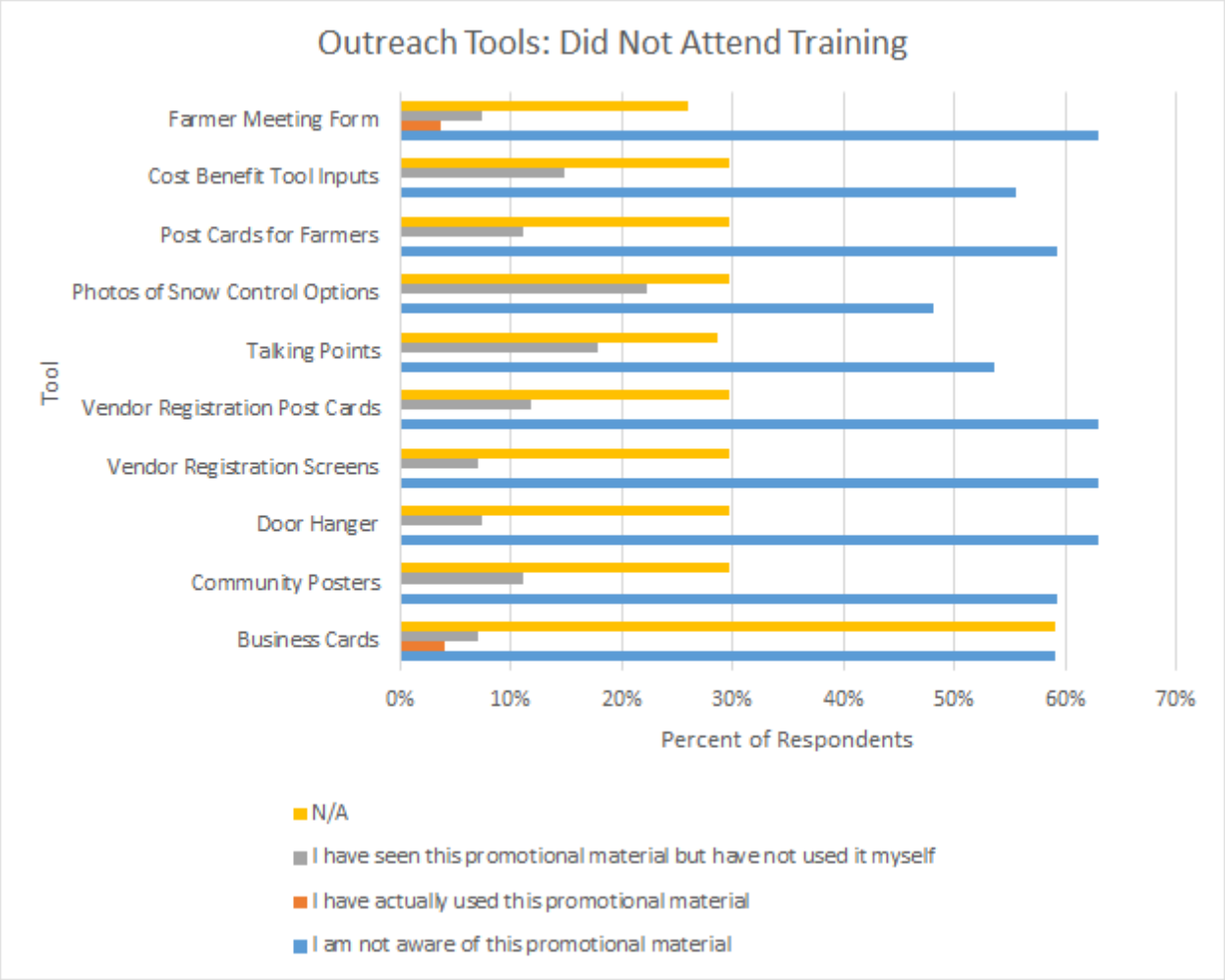


Figure 5.29 Familiarity with Blowing-snow-control Promotional Tools Did Not Attend Training

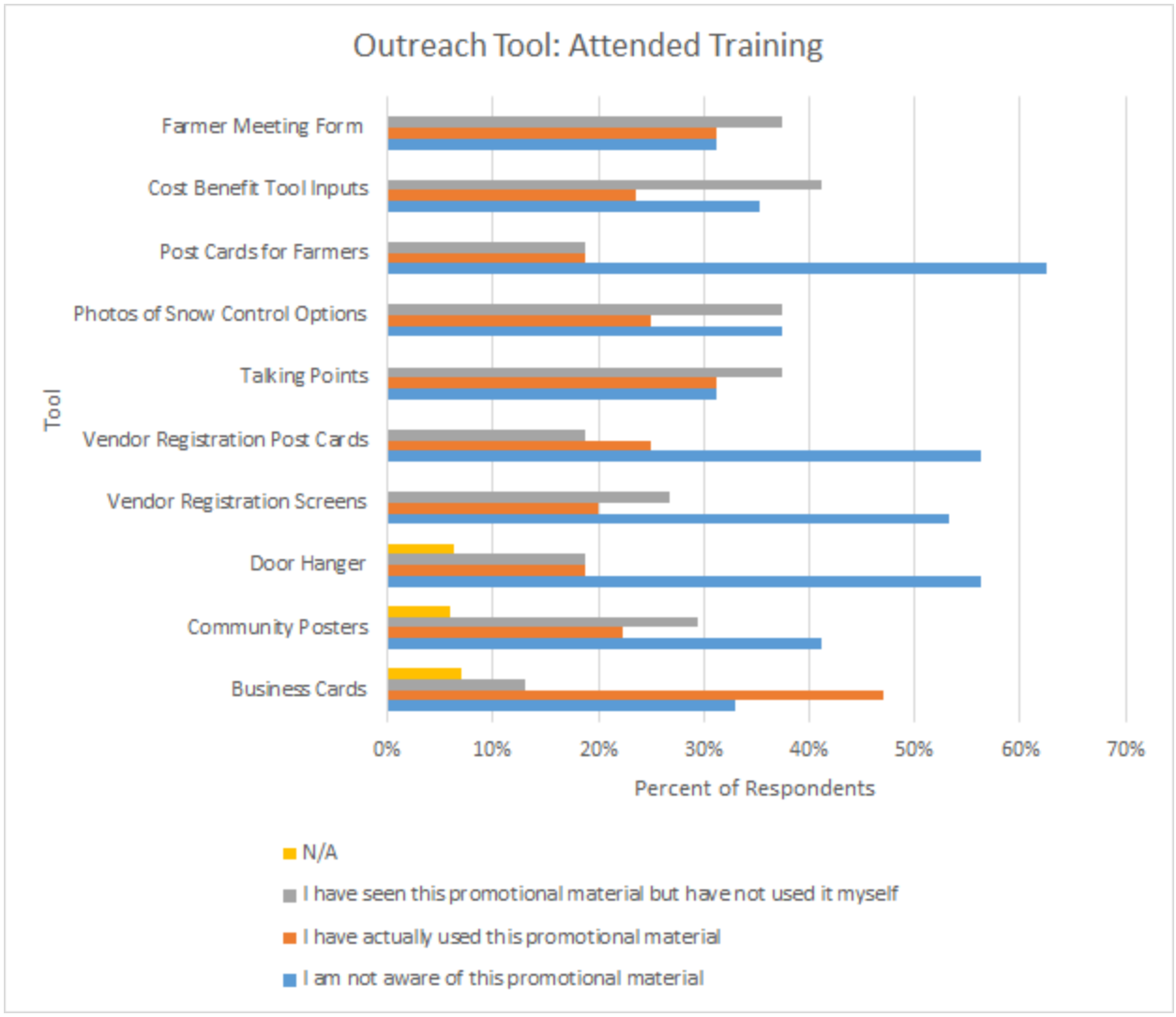


Figure 5.30 Familiarity with Blowing-snow-control Promotional Tools Attended Training

5.2.18 Q18: In your experience, is there a difference in willingness to adopt a temporary snow-control measure between landowners and renters?

47 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 5.61 below.

Answer Choices		Responses	
Yes (please describe in the space below)		17.02%	8
No		8.51%	4
Don't know		74.47%	35
Comment:	Responses	12.77%	6
Total Respondents: 47			

Figure 5.31 Difference in willingness to adopt temporary snow-control Descriptive Statistics

The majority of survey respondents (74%) reported that they do not know if there is a difference in willingness to adopt temporary snow-control measures between landowners and renters. Of the other respondents, people were nearly twice as likely to report that there was a difference (17%) than they were to report no difference (9%). While some said most will listen (regardless of being a landowner vs. a renter) and the only thing you need to do is speak with them, others identified several differences between landowners and renters. One individual pointed out that it really depends upon who is responsible for installation and who receives the money for participating (for example, a renter might not be enthusiastic if the landowner gets the check for standing corn). Several respondents also explained that renters are less likely to be willing to leave out corn bales because of the added work it requires. In addition, people pointed out that it can be difficult because you need support from both renters and landowners instead of just one stakeholder. Even if renters are willing to work with you they still need the permission of the landowner and sometimes the landowner is unwilling to permit snow fencing on their property. Similarly, if landowners are interested and renters are not that can also be a barrier.

5.2.19 Q19: In your experience, is there a difference in willingness to adopt a permanent snow-control measure between landowners and renters?

47 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 5.32 below.

Answer Choices		Responses	
Yes (please describe in the space below)		12.77%	6
No		8.51%	4
Don't know		78.72%	37
Comment:	Responses	10.64%	5
Total Respondents: 47			

Figure 5.32 Difference in willingness to adopt permanent snow-control Descriptive Statistics

The majority of survey respondents (79%) reported that they do not know if there is a difference in the willingness to adopt permanent snow-control measures between landowners and renters. 13% reported that yes there is a difference while 9% reported that there is not a difference. People commented and pointed out that renters always have to check with the landowner and that often willingness to participate is highly dependent upon the rental agreement and how much acreage the measure would take out of production. As one individual pointed out:

"If the landowners did not count the acreage used for a permanent measure in calculating the size of their field then it would work well. Renters only want to pay for the land they are able to profit from."

Survey respondents also pointed out that people do not want to take high priced land out of production and owners are often more willing to work with them compared to renters.

5.2.20 Q20: In your experience, are landowners happy with the existing blowing-snow-control program?

47 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 5.33 below.

Answer Choices		Responses	
Yes		21.28%	10
No		2.13%	1
Don't know		63.83%	30
Other (please specify)	Responses	12.77%	6
Total			47

Figure 5.33 Landowner Happiness with the Existing Blowing-snow-control Program Descriptive Statistics

The majority of survey respondents (64%) reported that they do not know the answer to this question. The second most popular answer (21%) was "Yes" and only one participant said "No." Of the participants who chose the "other" option (13%), most pointed out that, it really depends upon the landowner. A few people pointed out that landowners are still not very aware of the blowing-snow-control program and that people are most happy with the program when they think the monetary compensation is good or if it is on other people's land. One person also explained that other factors affect landowner satisfaction with the program other than financial incentives:

"The ones [landowners] I have dealt with are ok with it because it helps them out on their travel to town or work. When that situation ends I think they will stop the practice because the payment alone won't be enough incentive."

5.2.21 Q21: What do you think prevents farmers from signing up in MnDOT's blowing-snow-control program?

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.34 below.

Answer Choices		Responses	
They are renters		22.92%	11
Lack of awareness about the program		58.33%	28
Lack of time		18.75%	9
Lack of interest		33.33%	16
Lack of trust in a government agency		39.58%	19
Lack of familiarity with MNDOT bureaucratic procedures		33.33%	16
They may be farming in the MNDOT right of way		29.17%	14
Snow fencing in the fields obstructs large farm equipment		33.33%	16
They don't want to harvest corn in the spring		56.25%	27
Don't know		18.75%	9
Other (please specify)	Responses	10.42%	5
Total Respondents: 48			

Figure 5.34 Landowner Deterrents Descriptive Statistics

According to survey respondents, the most common factor that prevents landowner participation in the snow-control program is lack of awareness about the program (58%). Other commonly cited factors included that people do not want to harvest corn in the spring (56%) and lack of trust in a government agency (40%). The least commonly cited factors included lack of time (19%) or other (10%). Respondents that marked "other" described several additional deterrents to participation including: snow fencing

causes excess moisture in fields from snow piles (while this is also seen as a benefit in more arid states, it can be inconvenient in Minnesota), and the fact that some blowing-snow-control measures take land out of production. One participant explained:

"Farmers want to farm all of the land that they own that they are able to. I don't know too many that would willingly give up farmable land for not much return long term."

5.2.22 Q22: How should we obtain landowner interest in adopting temporary or permanent blowing-snow-control measures?

48 individuals answered this question, while one skipped it. Descriptive statistics are presented in Figure 5.35 below.

Answer Choices		Responses	
Incentives		68.75%	33
Easements		20.83%	10
Being involved in the decision-making process		45.83%	22
Educational outreach to local landowners on blowing snow measures		68.75%	33
Signage recognizing the landowner as a program participant		45.83%	22
Other public recognition in a local newspaper		25.00%	12
Don't know		8.33%	4
Other (please specify)	Responses	6.25%	3
Total Respondents: 48			

Figure 5.35 How to obtain landowner interest in adopting blowing-snow-control measures Descriptive Statistics

The majority of respondents (69%) indicated that MnDOT should provide educational outreach to landowners about blowing-snow-control measures and thought that incentives (69%) should be given to increase landowner interest. 46% of individuals reported that landowners should be involved in the decision-making process. Respondents also indicated that recognition, either in the form of signage recognizing the landowner as a participant (46%) or other public recognition in a local newspaper (25%) should be used to increase landowner interest. An additional 8% of individuals responded with "don't know" and another 6% indicated "other". The other suggestions all focused upon speaking directly with farmers and included: starting outreach earlier in the spring, being aware of crop rotations and what crops farmers plan to establish from year-to-year, and doing everything possible to get one-on-one time with farmers including going to local fairs and other events that attract the farming community.

This data illustrates that there may be other methods of obtaining landowner interest aside from the typical methods that MnDOT is currently using. While incentives and easements are typical tools utilized by MnDOT

to encourage landowner engagement, there may be other means of incentivizing participation that are not captured in this survey. For example, results from both question 21 and 22 indicate that survey respondents believe that promoting awareness of the program would also result in more landowner participation.

However, it is also important to note that this information and the information provided in the previous questions is secondary perception and does not directly reflect landowner opinions. More research needs to be performed involving local landowners and their incentives for participating in MnDOT's living snow-fence program. The question of landowner opinions is a topic that should be further explored through more direct work with landowners. MnDOT should not use this data to make decisions based on landowner opinions.

5.2.23 Q23: Have you talked with local residents about blowing-snow?

48 individuals answered this question; one skipped it. Descriptive statistics are presented in Figure 5.36

Answer Choices	Responses
Yes (If yes, what observations have they made about blowing snow? Please comment in the space below)	35.42% 17
No	64.58% 31
Comment: Responses	25.00% 12
Total Respondents: 48	

Figure 5.36 Communication with Local Residents Descriptive Statistics

The majority of respondents (65%) indicated that they have not talked with local residents about blowing-snow. 35% said that they have communicated with local residents. Respondents who have spoken with landowners reported that:

- Landowners have seen blowing-snow, soil erosion, and ditches getting filled with dirt and stalks on their property
- Many landowners don't want to take the extra time that some snow-control measures require
- Some landowners store things in the right-of way
- Some landowners do not like the program, but many love it once they see the projects showing benefits (snow-control and money).

Figure 6.38 below shows a cross tabulation of workshop attendees and non-attendees communication with local residents. These results are interesting because it shows that non-attendees actually reported interacting with landowners more often than workshop attendees did.

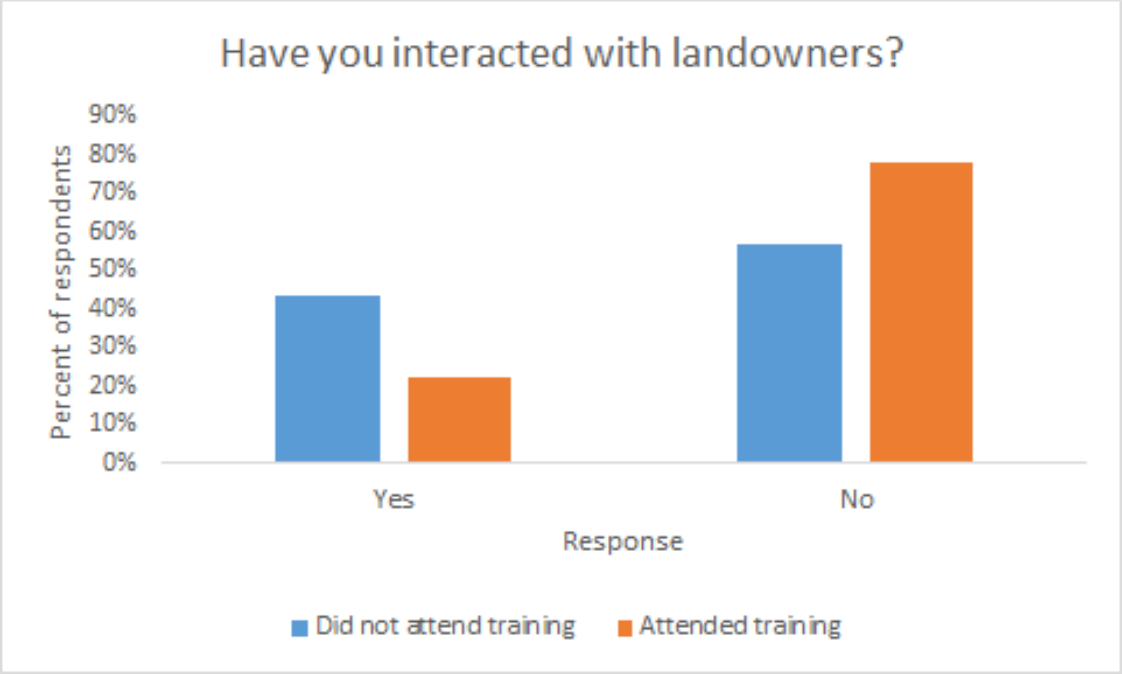


Figure 5.37 Communication with Local Residents Crosstabs

5.2.24 Q24: What prevents you from implementing snow-control measures?

47 individuals answered this question; two skipped it. Descriptive statistics are presented in Figure 5.38

Answer Choices	Responses	
Lack of time and compensation to work on snow control measures	25.53%	12
Lack of knowledge	17.02%	8
Lack of training	19.15%	9
Lack of funding	12.77%	6
Extensive permit/environmental review documentation that could delay the project	6.38%	3
Lack of available highway right of way	17.02%	8
Not a priority	10.64%	5
Don't know	31.91%	15
Other (please specify) Responses	23.40%	11
Total Respondents: 47		

Figure 5.38 Barriers to Implementation Descriptive Statistics

Of the 47 individuals responding to this question, 15 of them (32%) indicated that they do not know what prevents them from implementing snow-control measures. Of the others, 26% indicated that the largest barrier was lack of time and compensation for work, followed by lack of training (19%), lack of available highway right of way (17%), lack of knowledge (17%), lack of funding (13%), "not a priority" (11%), and finally the extensive permit and review documentation that could delay the project (6%). 11 individuals (23%) also selected "other", writing in their own answers. Several individuals said that the question did not apply to them. One person explained that they are in design and did not work with the public very much. Others pointed out that there are operations within MnDOT that are obstacles to implementing blowing-snow-control measures. One said that they have been told to wait and not follow through on blowing-snow-control because MnDOT did not want to spend funds on the project. Others said that they were not given sufficient time to do landowner outreach when it was most important. One explained:

"We need to be talking to farmers in spring and summer and not at harvest time."

Others explained that farmers are not interested, MnDOT does not own the land on the right-of way in some problem areas, and that some problem areas are on country roads where MnDOT funds are not available. Figure 5.39 shows a cross-tabulation of perceived barriers broken down based upon training attendance. It shows that individuals who did not attend the training were more likely to report that they do not know about factors that are barriers to implementing blowing-snow-control. Individuals who attended the training were significantly more likely to identify lack of time and compensation as a barrier.

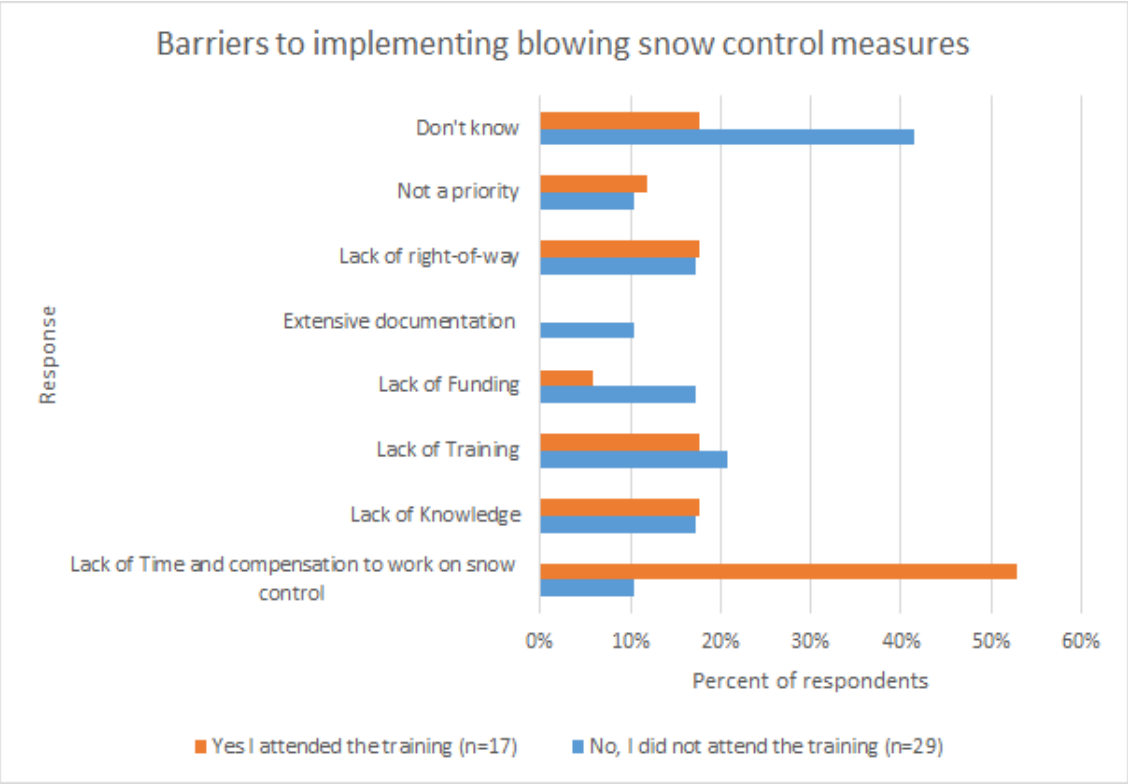


Figure 5.39 Barriers to implementing Blowing-snow-control Measures Crosstabs

5.2.25 Q25: What would help you to implement snow-control measures?

45 individuals responded to this question, four skipped it. Descriptive statistics are presented below in Figure 5.40.

Answer Choices		Responses	
Opportunity for overtime and compensation for extra hours worked		22.22%	10
Training in communication with landowners		24.44%	11
Training about the program and incentives		28.89%	13
Training about the technical aspects of snow control measures		26.67%	12
Recognition		8.89%	4
Don't know		35.56%	16
Other (please specify)	Responses	22.22%	10
Total Respondents: 45			

Figure 5.40 What would help you to implement snow-control measures Descriptive Statistics

Of the 45 individuals responding to this question, 36% of them indicated that they "don't know" what would help them to implement snow-control measures. 29% responded that training about the program and incentives would help, followed by technical training (27%), training in communication with landowners (24%), and opportunities for overtime and compensation for additional hours worked (22%) and recognition (8%). Additionally, 10 individuals (22%) checked "other". While some people commented that this question did not apply to them, others suggested making it more of a visible program, understanding the program's true benefits or cost savings, and having more time to work on blowing-snow-control. One individual also said that MnDOT management should be more open to flexibility and suggestions from staff. Figure 5.41 shows a cross tabulation between workshop attendees and non-attendees.

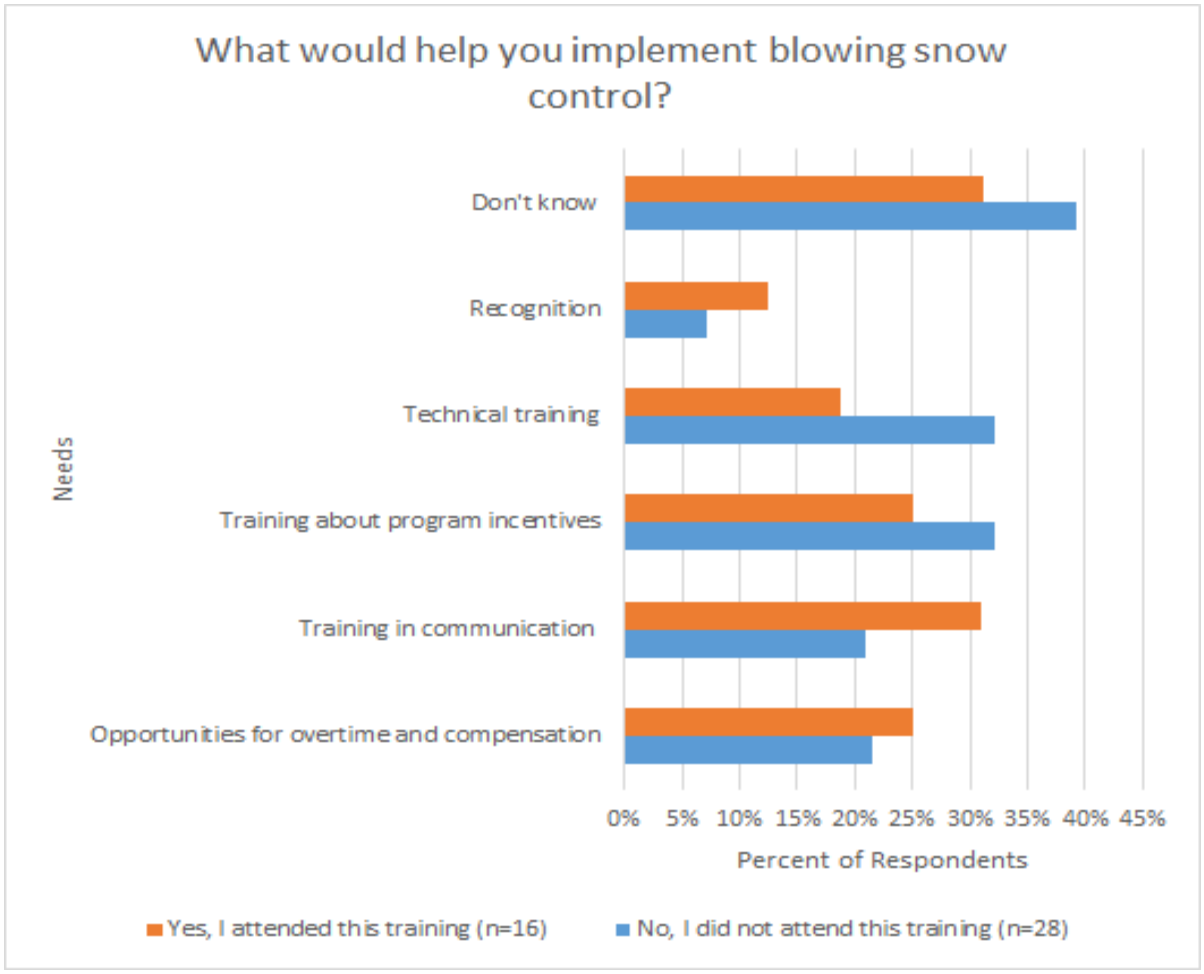


Figure 5.41 What would help you implement blowing-snow-control Crosstabs

5.2.26 Q26: Do you think that landowners are concerned about blowing-snow?

47 individuals answered this question; two skipped it. Descriptive statistics are given in Figure 5.42 below.

Answer Choices		Responses	
Yes		53.19%	25
No		17.02%	8
Don't know		12.77%	6
Other (please specify)	Responses	17.02%	8
Total			47

Figure 5.42 Are landowners concerned about blowing-snow? Descriptive Statistics

Over half (53%) of respondents indicated that landowners are concerned about blowing-snow, while 17% reported that they are not concerned and 13% reported that they do not know. Of those indicating "other" (17%), most pointed out that some landowners are while others are not. One respondent mentioned that small farmers are more likely to be concerned compared to larger farms. They also point out that the individuals who are not concerned do not see the problems that blowing-snow causes. People are more likely to be concerned if it has a direct impact on their lives. As mentioned above, it is important to emphasize that this information does not represent a direct measurement of landowner knowledge and perceptions but rather a measurement of MnDOT employees' interpretations of landowner perceptions.

5.2.27 Q27: Do you think that landowners see benefits from blowing-snow-control?

48 individuals responded to this question; one skipped it. Descriptive statistics are given in Figure 5.43

Answer Choices		Responses	
Yes		62.50%	30
No		4.17%	2
Don't know		18.75%	9
Other (please specify)	Responses	14.58%	7
Total			48

Figure 5.43 Do landowners see benefits from blowing-snow-control. Descriptive Statistics

Over half (63%) of survey respondents reported that yes, they do believe that landowners see benefits from blowing-snow-control. 19% indicated that they do not know and two (4%) indicated that no, landowners do not see benefits from blowing-snow-control. 15% of respondents marked "other." Many individuals wrote that they were unsure, maybe, or that it depended upon the circumstance. Some pointed out that

landowners do not see the benefit when they are not educated, but that once they know they recognize the value. Another respondent said that landowners saw the benefit on roadways but not on their property.

5.2.28 Q28: What do MnDOT employees need to know so they can better communicate with landowners about blowing-snow-control?

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.44 below.

Answer Choices	Responses	
Communication skills	54.17%	26
Conflict management skills	39.58%	19
Knowledge about blowing snow control measures (technical aspects)	70.83%	34
Costs/benefits of blowing snow control	62.50%	30
A greater understanding of MNDOT's blowing snow control process and standard operating procedures	66.67%	32
Don't know	8.33%	4
Other (please specify) Responses	2.08%	1
Total Respondents: 48		

Figure 5.44 What employees need to know to better communicate with landowners Descriptive Statistics

Of the 48 individuals responding to this question, 71% reported that knowledge about the technical aspects of various blowing-snow measures would help them communicate with landowners. The second-most frequent response (67%) was that a greater understanding of MnDOT's blowing-snow-control process and standard operating procedures would be helpful, followed by knowing the costs and benefits of blowing-snow-control (63%), communication skills (54%) and conflict management skills (40%). Additionally, four individuals (8%) reported that they do not know what employees need to know to better communicate with landowners about blowing-snow-control. One individual commented that they would also need clarification about whose responsibility blowing-snow-control falls under: whether it was something that maintenance crew worked on or the State. As Figure 5.45 below shows, training attendees were more likely to report that employees needed a greater understanding of the measures and the MnDOT process and the benefits of snow-control compared to non-attendees

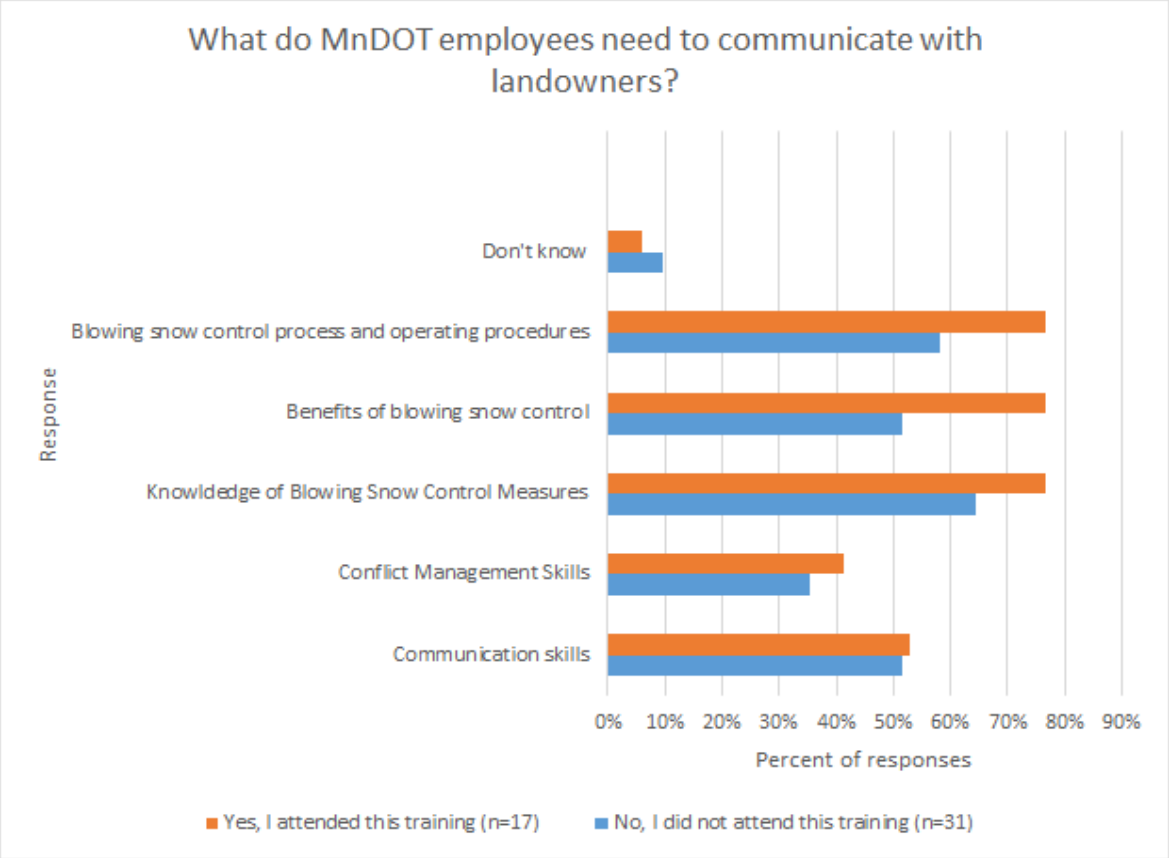


Figure 5.45 What employees need to know to better communicate with landowners Crosstabs

5.2.29 Q29: Are you willing to interact with landowners about blowing-snow-control?

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.46 below.

Answer Choices		Responses	
Yes		**33.33%**	16
Somewhat		**22.92%**	11
No		**6.25%**	3
Doesn't apply to me		**31.25%**	15
Don't know		**2.08%**	1
Other (please specify)	**Responses**	**4.17%**	2
Total			48

Figure 5.46 Willingness to interact with landowners Descriptive Statistics

Among all respondents, 33% reported that yes, they are willing to interact with landowners about blowing-snow-control. The second-most frequent response was that the question did not apply to the respondent, with 15 individuals (31%) selecting this response. 23% of respondents said that they were somewhat willing to interact with landowners and 6% responded that no, they were not willing to interact with landowners. Of the individuals who marked "other", one said that they might be willing to interact with landowners while the other believed that landowner interaction action is somebody else's job. They pointed out that if someone is already being paid to do this, so it is their responsibility. The cross tabulated calculations shown in figure 5.475shows that training attendees were more likely to state that they were willing to interact with landowners. Individuals who did not attend the training were much more likely to say that blowing-snow-control did not apply to them.

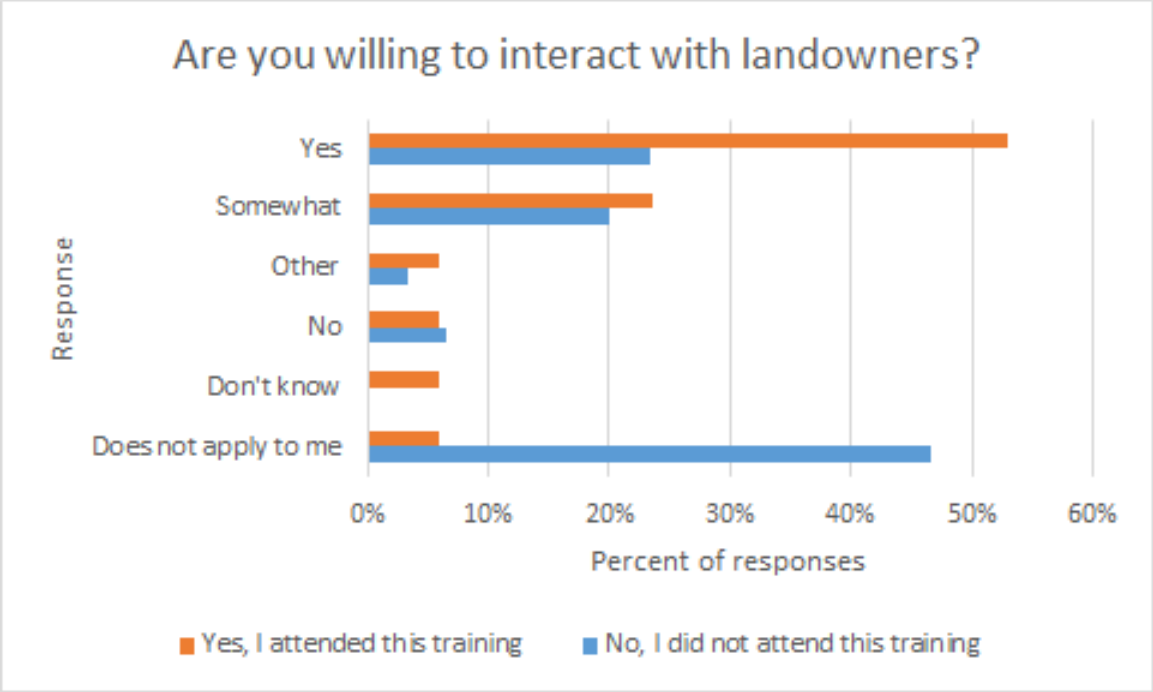


Figure 5.47 Willingness to interact with landowners Crosstabs

5.2.30 Q30: What would help you to more effectively recruit landowners to adopt blowing-snow-control measures?

21 individuals (43%) answered this question; 28 skipped it. Descriptive statistics are given in Figure 5.48

Survey Responses	Responses
Don't know/Not Applicable	14% (*n=3)*
More knowledge/training	29% (*n=6)*
Economic incentives	10% (*n=2)*
Time	14% (*n=3)*
Logistics	33% (*n=7)*
Other	10% (*n=2)*
Total Respondents: 21	

Figure 5.48 More effective landowner recruitment Descriptive Statistics

This was an open-ended question asking respondents to fill in answers. About 14% of respondents reported either that they do not know or that the question does not apply to them. The most common responses involved specific logistical details (33%) related to the snow-fence program or more knowledge/training needs (29%). Some of the specific logistical suggestions included: clarifying whose job blowing-snow-control falls under, being able to have dollar amounts available when you talk to landowner, talking to landowners earlier in the year, having a well-established and documented plan, having photos of installations in winter and summer to share with landowners, having the authority to communicate and sign-up landowners, and have one person take ownership of the process from start to finish to develop trust and avoid procedural lags. Some of the training needs suggested included: communication training, training about policies and practices related to blowing-snow-control, etc. Several respondents (14%) also indicated that having more time to work on blowing-snow-control and recruit landowners was important. Finally, a few respondents suggested that increasing economic incentives (10%) for landowners would be effective. One person explained:

"Planting trees is a long-term loss for farmers, due to the lost profits [they would have gained] if they had continued to farm the land. Standing cornrows is also not profitable, as the yield when they can harvest is reduced due to winter conditions/wildlife."

5.2.31 Q31: Can you suggest any opportunities for public outreach and knowledge sharing on blowing-snow-control?

19 individuals answered this question; 30 skipped it. Descriptive statistics are given in Figure 5.49 below.

Survey Responses	Responses
Mass Communication	39% (*n=7)*
On-location presentations	44% (*n=9)*
Collaborations	17% (*n=3)*
Within MnDOT	11% (*n=2)*
Messaging	6% (*n=1)*
Total Respondents: 19	

Figure 5.49 Outreach Opportunity Suggestions Descriptive Statistics

Most commonly, respondents suggested presentations in locations within the community (44%). Such suggestions included setting booths at events where local farmers gather such as the civic center, farm shows, county and state fairs, and farmfest. They also suggested hosting informational open houses or going door-to-door to local farms and introducing yourself/shaking people's hands and educating farmers. Respondents also suggested using mass communication (39% of comments) in the form of written bulletins, mailers and handouts, newspapers, social media, post cards, online information, media coverage, or radioed advertisements.

Finally, a few respondents (17%) suggested establishing collaborations for outreach with local government agencies, SWCD offices, the US Farm Bureau, local country Ag offices and local grain elevators. People also suggested doing more of outreach activities within MnDOT and providing a brief training for all employees at All Employee Day. Another participant also suggested messaging:

"The public is always concerned about how much the state is spending so maybe if you show them how much it would save in labor and fuel maybe it would change their mindset."

5.2.32 Q32: How does implementing blowing-snow-control rank in your day-to-day work priorities?

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.50 below.

Answer Choices		Responses	
Very high		8.33%	4
Somewhat high		12.50%	6
Neutral		25.00%	12
Not very much		25.00%	12
Not at all		8.33%	4
Doesn't apply to me		16.67%	8
Other (please specify)	Responses	4.17%	2
Total			48

Figure 5.50 How does implementing blowing-snow-control rank in priorities Descriptive Statistics

Of the 48 individuals that responded to this question, half reported that implementing blowing-snow-control is a “neutral” priority (25%) or not very much of a priority (25%) in their daily work. eight individuals (17%) reported that this question does not apply to them. On the two ends of the spectrum, ten individuals (21%) reported that implementing blowing-snow-control was either “very high” or “somewhat high” in their work priorities and four individuals (8%) prioritized it “not at all”. The individuals that marked other (4%) pointed out that it could be a higher priority and that it might be a good winter activity.

As the cross-tabulation in Figure 5.51 (training attendance x how does implementing blowing-snow-control rank in your work priorities) shows, only individuals that did not attend the training indicated that blowing-snow-control did not apply to them or was not a high priority at all. This can show that people who attended the training were more likely to consider blowing-snow-control to be part of their job. However, it is possible that there is some bias in this finding if individuals who attended the training were already more likely to consider blowing-snow-control to be part of their job or already involved/interested in blowing-snow-control. This factor could have influenced their decision to attend the training as well as their consideration of blowing-snow-control to be a high priority.

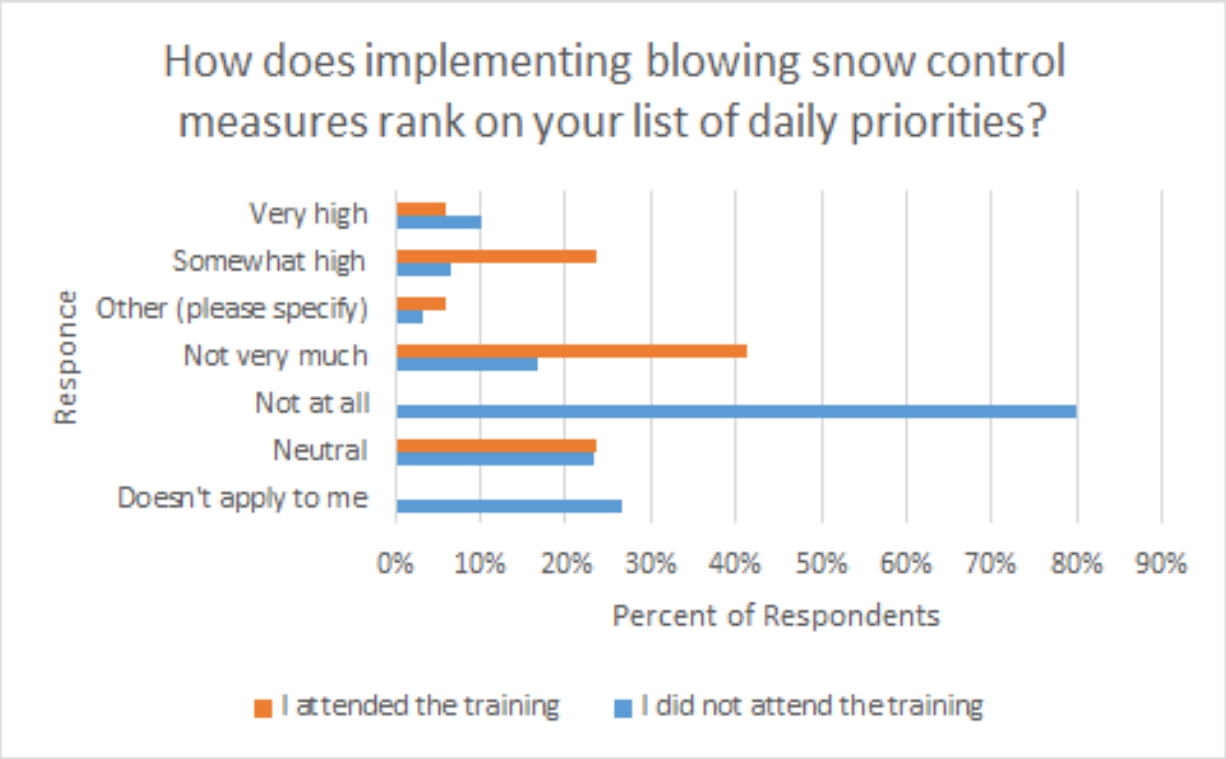


Figure 5.51 How does implementing blowing-snow-control rank in priorities? Crosstabs

5.2.33 Q33: In your experience, does MnDOT's blowing-snow-control program have a favorable public image?

46 individuals answered this question; three skipped it. Descriptive statistics are given in Figure 5.52 below.

Answer Choices		Responses	
Favorable		**19.57%**	9
Somewhat favorable		**23.91%**	11
Neutral		**13.04%**	6
Somewhat unfavorable		**0.00%**	0
Don't know		**36.96%**	17
Other (please specify)	**Responses**	**6.52%**	3
Total			46

Figure 5.52 Blowing-snow-control program favorable public image Descriptive Statistics

Of the 46 respondents, 37% reported that they do not know whether MnDOT's blowing-snow-control program has a favorable public image. The next most frequently selected response was that the program's public image was somewhat favorable (24%) followed by favorable (20%). Nobody indicated that they thought the program was seen unfavorably. One individual responding with "other" left a comment explaining that the program's public image is favorable for the "traveling public", but not to landowners:

"Favorable to the traveling public because it helps keep roads clear. Not always favorable for the landowner who has a permanent measure installed on their property"

Others wrote that they do not think that many people are aware of the program. Figure 5.53 shows these results graphically

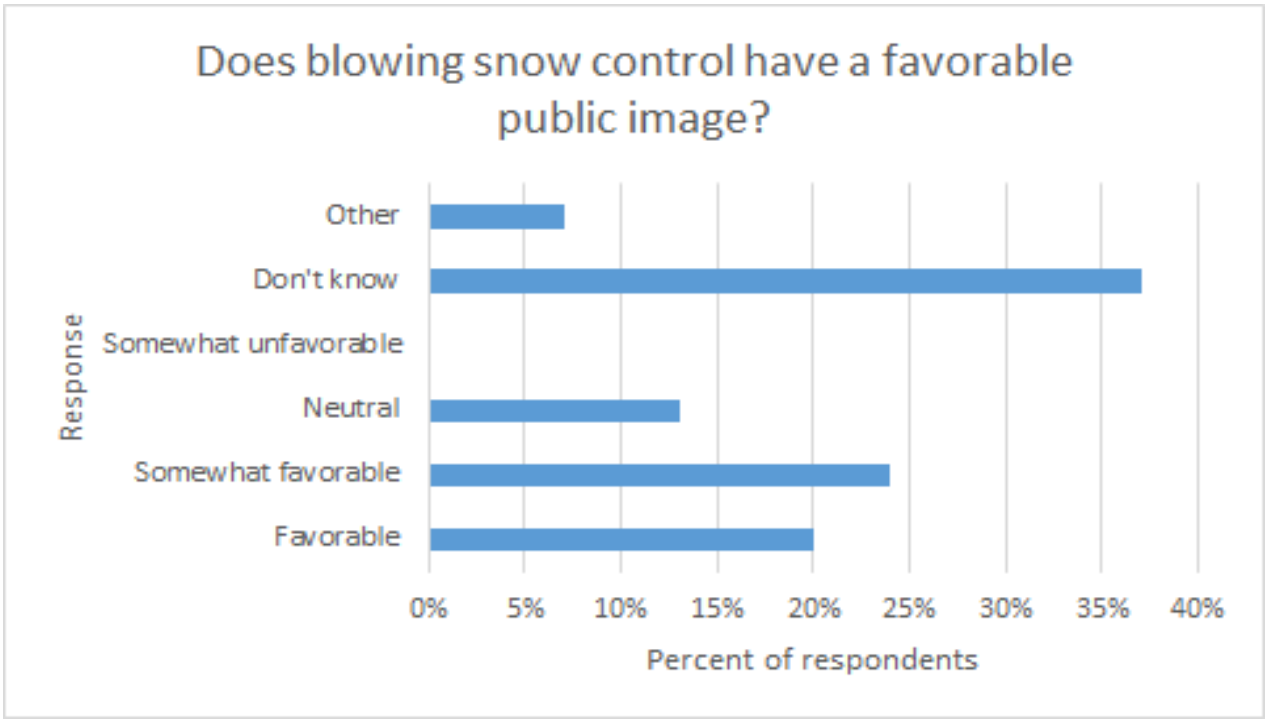


Figure 5.53 Blowing-snow-control program public image Bar Graph

5.2.34 Q34: In your experience is MnDOT's blowing-snow-control favorably received by farmers.

48 individuals answered this question; one skipped it. Descriptive statistics are given in Figure 5.54 below.

Answer Choices		Responses	
Yes		**8.33%**	4
Somewhat		**33.33%**	16
Neutral		**8.33%**	4
No		**2.08%**	1
Don't know		**45.83%**	22
Other (please specify)	**Responses**	**2.08%**	1
Total			48

Figure 5.54 Is MnDOT's blowing-snow-control favorably received by farmers. Descriptive Statistics

Most participants (46%) reported that they do not know if farmers favorably receive blowing-snow-control. This reflects that many survey participants do not directly work with farmers. Other respondents reported that the program is somewhat well received (33%). One individual wrote that farmers are more likely to favorably receive the program once they understand the available reimbursements. These results are shown graphically in Figure 5.55 below. Results to Questions 33 and 34 suggest that MnDOT employees generally do not know how the blowing-snow-control program is viewed by others in the community. Again, it is important to note that this is not a true measure of public opinion of MnDOT's blowing control but rather MnDOT employee's perception of public opinion. For more information on public opinion of these measures, further social research is necessary.

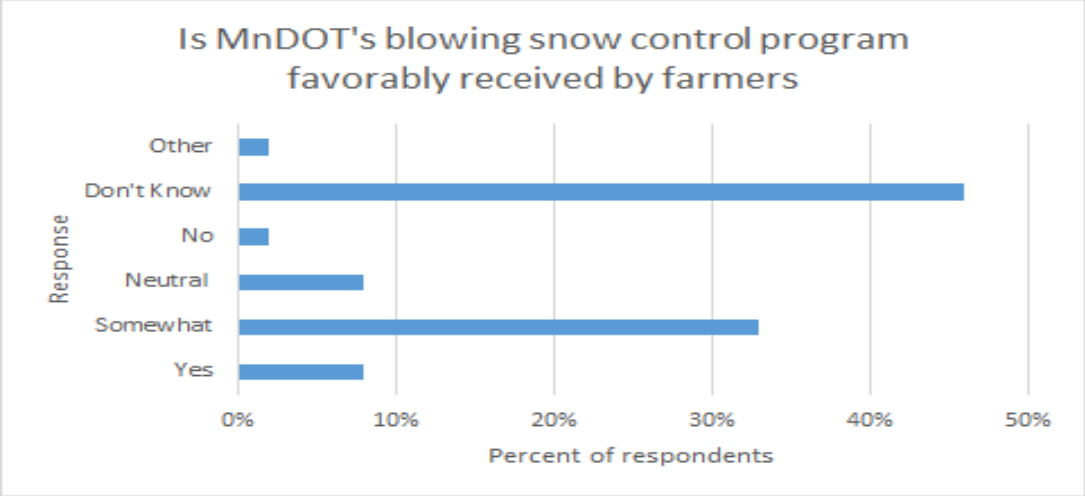


Figure 5.55 Is MnDOT's blowing-snow-control favorably received. Bar Graph

5.2.35 Q35: In your opinion, what is an effective blowing-snow-control measure?

This was an open-ended question, asking respondents to write-in their answers. 29 individuals answered this question; 20 skipped it. Descriptive Statistics are in Figure 5.56

Survey Responses	Responses
Don't know or neutral	8% (*n=2)*
Anything	15% (*n=4)*
Other	8% (*n=2)*
Living snow-fences	15% (*n=4)*
Standing corn rows	35% (*n=9)*
Permanent measures	8% (*n=2)*
Temporary measures	8% (*n*=2)
CRP grass fields	4% (*n=1)*
Stacking bales	4% (*n*=1)
Road design/grade	12% (*n*=3)
Total Respondents: 29	

Figure 5.56 Effective Blowing-snow-control Measures Descriptive Statistics

Several respondents made suggestions about different measures or pointed out that anything that prevents the snow from reaching the road is effective. Some individuals listed specific practices, such as living fences or standing rows of crops, while others listed the qualities of a good blowing-snow-control measure. Some of the qualities of a good blowing-snow-control measure included: something that adds to the surrounding landscape, something that fits well with current and future land use and anything that causes minimal hardship to the farmer. In addition, it needs to be obvious to the farming community that the measure does not results in production loss or adds to production.

Of the 29 respondents, two individuals (8%) said that they did not know or were neutral. The most commonly cited blowing-snow-control practices included: standing cornrows (35%), living snow-fence (15%), road design (3%), permanent measures (8%), and temporary measures (8%). People also listed CRP grass fields, and stacking bales. Corn rows were the most commonly cited practice and several respondents elaborated that standing corn because it is easy to set up and take down and it is effective.

5.2.36 Q36: Do you have any suggestions for the blowing-snow-control program?

This was an open-ended question, asking respondents to write-in their answers. 24 individuals answered this question; 25 skipped it. Descriptive statistics are given in Figure 5.57 below.

Survey Responses	**Responses**
No suggestions	29% (*n=7)*
Logistic Suggestions	33% (*n=8)*
Landowner Outreach Suggestions	8% (*n=2)*
Communication and marketing suggestions	25% (*n=6)*
Other	4% (*n=1)*
Total Respondents: 26	

Figure 5.57 Suggestions for the blowing-snow-control program - Descriptive Statistics

Of those who answered the question, eight (31%) wrote that they did not have a suggestion. One respondent also elaborated by saying:

"I don't feel I have enough knowledge about the program to make an educated suggestion."

The remaining responses offered a number of suggestions that fell into a few overarching themes: logistics (n=8, 33%), landowner outreach (n=2, 8%), and communication and marketing both within MnDOT and with landowners (n=6, 25%).

Logistic suggestions included general comments related to providing more funding and time as well as clarifying whose job the snow-fences fall under (who is being paid?) and setting snow-fences as a priority job assignment. Some respondents also provided specific suggestions related to the logistics of the snow-fence program including:

- Start earlier. Blowing-snow-control needs to be scoped into projects from the beginning so that right-of-way can be purchased
- The state vendor process is difficult

One participant also suggested that MnDOT rent more tracked skid loaders with blowers for cleanup when necessary and forget about the fencing all together.

The communications and marketing suggestions focused upon promotion and included communication about blowing-snow-control within MnDOT and communication with the public. Several employees said that the blowing-snow-control program needed to be more public within MnDOT. They said they had never heard about it and that MnDOT should have more meetings about it and more education available to the people promoting the program. One individual wrote:

"When your own employees don't know anything about it how is the public suppose[d] to?"

Other communication suggestions for the public included setting up a booth at the Gillfellian estate by Redwood Falls in August and talking with individuals inside industry to garner support and help promote the program.

A few respondents also provided specific suggestions related to landowner outreach and snow-control measures that landowners would find acceptable:

"I believe farmers don't want to hassle with leaving crop in the field. MnDOT could supply orange snow-fence for landowners and have them install like through an adopt-a-highway program."
"Pay farmers for standing corn stalks. Then in spring, you just have to disk them. Offer them something like $300.00/acre.

5.3 CONCLUSTION AND RECOMMENDATIONS

Analysis of the Second KAP survey results yielded several important considerations. The following section summarizes these findings and provides recommendations.

5.3.1 Key Findings

5.3.1.1 Survey Participants

It is important to point out the fact that the groups of MnDOT employees that filled out the first and second-round KAP surveys were not identical. Approximately 41% of the second-round survey participants indicated that they had also filled out the first-round survey. Another 31% had not filled out the first-round survey and another 29% could not recall. Second-round KAP survey respondents were slightly more involved with farming compared to first-round KAP survey respondents and the second-round KAP respondents had relatively more program delivery staff respond, and less maintenance operations staff respond compared to the first-round KAP study. This means that while some conclusions can be garnered from these results, we cannot use them to show individual changes in knowledge, attitudes, and practices over time because the data represents two different groups of participants.

5.3.1.2 Differences in knowledge, attitudes, and practices between First-round KAP Survey and Second-round KAP Survey

When compared to the results of the first-round KAP study, the second-round KAP results show some large differences in knowledge, attitudes, and practices. For example:

- Compared to the first-round KAP, more second-round survey respondents were able to identify the temporary and permanent blowing-snow-control options currently utilized by MnDOT (Question 7 & 8).
- Second-round survey participants reported having a greater familiarity with blowing-snow-control tools (Question 13) compared first-round survey participants.
- Second-round KAP participants were twice as likely to correctly identify the Craig Gertsema, the MnDOT District 8 Living Snow-fence Coordinator, as well as Dan Gullickson, the statewide snow-fence coordinator compared to first-round KAP respondents (Questions 14 & 15).
- Compared to the first-round KAP survey, second-round KAP survey respondents were about 50% less likely to state that they did not know how to obtain landowner interest in adopting blowing-snow-control measures (Question 22).
- Compared to the first-round KAP survey, fewer respondents reported that implementing blowing-snow-control did not apply to them, or was not part of their job description (Question 32).

These results are encouraging as these themes were all covered during the workshops (see agenda in methods) and may indicate a positive progression.

5.3.1.3 Differing Knowledge and Perspectives between MnDOT Staff that attended training and staff that did not attend training

To provide further evidence for these results, we performed crosstabulation calculations on several questions to separate the answers of second-round KAP survey respondents who had attended the training (35% of respondents) in May 2016 compared to respondents who had not attended the training (63% of respondents). From records from the training, we know that 23 individuals attended the trainings in May 2016. This means that of the 23 people who attended the training, 74% filled out the second-round KAP survey.

A major conclusion revealed by the cross-tabulations by training attendance included in the analysis above is that the employees who attended the training had different answers to many questions compared to employees who did not attend the training. For example:

- In general, staff that reported that they attended the training were significantly more likely to identify each temporary measure currently utilized by MnDOT and slightly more likely to identify permanent measures used by MnDOT compared to survey participants that did not attend the training.

- Training attendees were also more familiar with different blowing-snow-control practices as well as vastly more likely to have used the various blowing-snow-control practices compared to non-attendees (Question 9).
- Training attendees were also significantly more likely to have seen blowing-snow-control tools compared to individuals who had not attended the training (Question 13).
- Training attendees were significantly more likely to know that Craig Gertesma is the District 8 Living Snow-fence Coordinator and that Dan Gullickson is the state snow-fence coordinator while non-attendees were significantly more likely to report that they did not know who the state snow-fence coordinator or the District 8 Coordinator are (Questions 14 & 15).
- Individuals who had attended the training were more likely to report that they were either aware of, or had used the blowing-snow-control promotional tools. Respondents who did not attend the training were significantly more likely to report that the promotional tools did not apply to them (Question 17).
- Training attendees were more likely to state that they were willing to interact with landowners (Question 19). Individuals who did not attend the training were much more likely to say that blowing-snow-control did not apply to them. Part of the training was showing how blowing-snow-control and interaction with landowners applied to each job position within MnDOT. These results show how this effort was effective.
- People who attended the training were more likely to consider blowing-snow-control to be part of their job. Only individuals that did not attend the training indicated that blowing-snow-control did not apply to them or was not a high priority at all (Question 32).

These results further support the hypothesis that workshop participation seemed to have several of the desired positive impacts on MnDOT staff. However, Individuals who attended the training were also significantly more likely to identify lack of time and compensation as a barrier to implementing blowing-snow-control. This may indicate that once MnDOT staff are trained, there are still barriers that prevent them from implementing snow-control measures. Solutions such as increased overtime or more recognition for hours worked might be means of addressing these barriers.

There may be a source of bias that accounts for some of these results: if MnDOT employees that were more knowledgeable, interested in, or involved with blowing-snow-control were more already likely to attend the training last year, then these results may be biased. In that case, the differences in responses between training attendees and non-attendees may be due to more than just training attendance.

5.3.2 Key Recommendations

The findings from the Second KAP Study also generated several recommendations aimed at improving the MnDOT's blowing-snow-control program. These recommendations included suggestions for future training, suggestions for communicating with landowners, and recommendations focused upon specific logistics within MnDOT's blowing-snow-control program.

5.3.3 Logistic Recommendations

Individuals working in the program provided specific logistic recommendations for improving the program:

- As mentioned previously, individuals who attended the training were significantly more likely to identify lack of time and compensation as a barrier to implementing blowing-snow-control
- Some respondents suggested that any type of blowing-snow-control would have a positive effect. They suggested that it might be effective (and cheaper) to pay landowners to leave only corn stalks instead of entire rows.
- Respondents pointed out that there are operations within MnDOT that are obstacles to implementing blowing-snow-control measures (Question 24).
- One respondent reported that funds are not always available for blowing-snow-control projects.
- Others said that they were not given sufficient time to do landowner outreach when it was most important and explained: *"we need to be talking to farmers in spring and summer and not at harvest time."*
- One individual suggested that being able to have dollar amounts available when you talk to landowner would be very helpful
- One individual suggested having a well-established and documented plan
- Others suggested having one person take ownership of the process from start to finish to develop trust and avoid procedural lags.
- Finally, people suggested promotional tools such as having photos of installations in winter and summer to share with landowners

5.3.3.1 Landowner Outreach Recommendations

Survey respondents also made several suggestions for improving landowner outreach. Most commonly, respondents suggested presentations in locations within the community. Such suggestions included setting up booths at events where local farmers gather such as the civic center, farm shows, county and state fairs, farmfest, etc. They also commonly suggested hosting informational open houses or going door-to-door to local farms and introducing yourself/shaking people's hands and educating farmers. Respondents also suggested using mass communication in the form of written bulletins, mailers and handouts; newspapers social media, post cards, online information media coverage or radioed advertisements for public outreach. Finally, a few respondents suggested establishing collaborations for outreach with local government agencies, SWCD offices, the US Farm Bureau, local country Ag offices and local grain elevators. Within MnDOT, people suggested doing more of outreach activities and providing a brief training for all employees at All Employee Day.

5.3.3.2 Training Recommendations

The results described above indicate that the trainings conducted in May 2016 were effective. However, individuals who did not attend the trainings still demonstrate lack of knowledge related to blowing-snow-

control measures, blowing-snow-control tools, blowing-snow-control coordinators, and how blowing-snow-control fits into their daily responsibilities. Future trainings with additional MnDOT staff members may effective. In addition, Figure 23.2 (Question 23) shows a cross tabulation of workshop attendees and non-attendees communication with local residents. These results are interesting because it shows that non-attendees actually reported interacting with landowners more often than workshop attendees did. These results may indicate future need for training. Many of the individuals who did not attend the training still interact with landowners. These individuals would benefit from the training.

Some suggestions for materials to include in an additional training are:

- A review of new blowing-snow-control promotional material that staff can use with landowners: Respondents most commonly reported that they were not aware of the promotional material (Question 17).
- Information on existing blowing-snow-control measures, especially less recognized blowing-snow-control measures such as mechanically wind rowing snow in farm fields.
- While more people were aware of tools available compared to the first-round survey, there is still a lack of knowledge in general about tools.
- Clarification of how blowing-snow-control fits into existing job responsibilities

5.3.4 Recommendations for Future Research

The first and second-round KAP studies highlighted an important gap in knowledge relating to the perceptions and motivations of landowners. Though there were many questions included in this survey relating to landowner perceptions and motivations, it is important to remember that the results do not directly represent actual landowner opinions. Rather, the results from this survey merely illustrate MnDOT employees' perceptions about landowners' opinions. Thus, MnDOT should not use this information to make conclusions or programmatic decisions related to actual landowner opinions.

The survey results do reveal that MnDOT tends to naturally orient towards financial and technical approaches, such as easements and incentives. However, past studies on landowner attitudes and practices have shown that there may be other, perhaps more effective, methods of obtaining landowner interest in addition to the approaches that MnDOT is currently using. Landowners may have other influential motivations relating to issues of safety, legacy or social conscience.

At this point, the main blowing-snow-control challenges faced by MnDOT are not technical, but rather they are related to the social problem of adoption. Understanding the complex social dimensions of blowing-snow-control is a necessary next step. Further research on landowner perceptions and motivations, in the form of a comprehensive and rigorous survey, will help MnDOT design new solutions and more effectively reach out to landowners. Key issues, such as differences in land ownership (renters versus owner operators) and their impacts on adoption, should be explored.

CHAPTER 6: MNDOT BLOWING-SNOW-CONTROL PROGRAM PARTICIPANT INTERVIEWS

6.1 INTRODUCTION

MnDOT District 8 has experienced a significant increase in landowner participation in their standing cornrow blowing-snow-control program. Figure 6.1 below shows this increase.

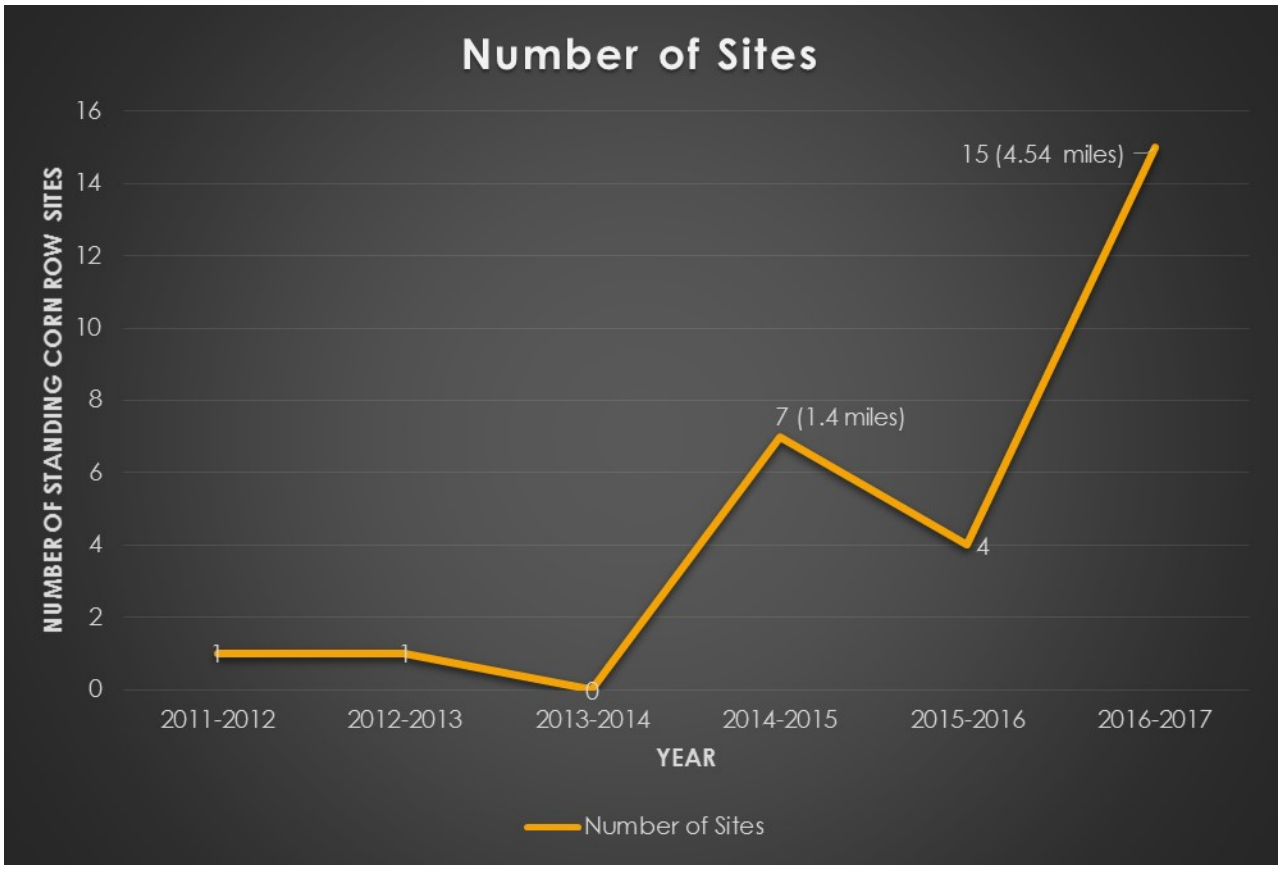


Figure 6.1 Number of Standing Corn Row Sites in MNDOT District 8.

In March 2017, University of Minnesota conducted phone interviews with six landowners that participated in MnDOT's blowing-snow-control program over the past year. The majority of these participants put up standing cornrows. Interviews lasted between 15 and 25 minutes each and participants were asked the following questions:

1. How did you learn about the program?
2. Why did you participate in the program?
3. What made it easy for you to participate in the program?
4. What made it difficult for you to participate in the program?

5. Was becoming a state vendor a problem for you?
6. Would you participate in the program again? Why or why not?
7. Do you have any suggestions for improving the program for next year?
8. Would you recommend participating in MnDOT's blowing-snow-control program to your neighbor? Why or why not?
9. Do you have suggestions for how MnDOT could encourage non-participating landowners to participate in this program?

6.2 RESULTS

Insights gained from each interview question are summarized below.

6.2.1 Question 1: How did you learn about the program?

The majority of participants had some sort of personal connection with a MnDOT employee. In most cases, the participant had previously known the MnDOT employee from their community. For example, one person explained:

In Redwood Falls there is a MnDOT shop and one of the people who works at the shop, contacted me. I already knew him. It is a small community.

The majority of these participants had face-to-face conversations about the program with someone from MnDOT. One participant also said that he learned about the program when someone from MnDOT stopped by and knocked on his door to explain the program. The participants who had not had a personal connection with MnDOT employee had previous experience with Snow-fences and recognized their value. These individuals had contacted MnDOT after seeing the program advertised in print media or after talking with neighbors who had participated in the program:

My neighbor did it and I saw the impact that it had on his section of road. That made a lot of people start talking about it. I talked to him about it and he gave me the information.

6.2.2 Question 2: Why did you participate in the program?

Most commonly, people said that they participated in the program because they saw the value of keeping the roads clear for themselves and their community. In many cases, participants recognized that blowing-snow was a problem on their roads in the winter and saw the benefit of the program. People often mentioned that it made them feel good to do something that was helping the community:

The feeling that I was doing something that could save a life by cutting down on stranded motorists and accidents, so it was worth it.

Other individuals mentioned that they were already familiar with snow-fences through previous projects or seeing neighbors participate in the program. Due to this previous experience, they knew that snow-fences worked:

I already knew about snow-fences and what they. So, when I got the information, it made sense and I decided to do it.

While several people pointed out that money was not the only reason why they participated in the program, many people did say that the money that MnDOT offers to participants was a good incentive.

6.2.3 Question 3: What made it easy for you to participate in the program?

In general, interviewees reported that it was easy to participate in the program. Several people mentioned that the MnDOT staff were easy to work with and made it easy to participate in the program:

"Everyone in MnDOT has been very easy to work with"

Another participant said that MnDOT's flexibility and willingness to participate also made it easy to participate explaining that:

We also got to experiment a little bit. For example, one year we put up two rows, but it actually dropped too much snow and caused a bit of a problem in the spring so then we went back to less.

6.2.4 Question 4: What made it difficult for you to participate in the program?

While some participants said that nothing made it difficult to participate, others provided specific examples of obstacles to participation:

Some reported that getting set up, as a state vendor was a big obstacle (this is discussed further below). Some others mentioned inconveniences with harvesting/planting in the spring. Participants mentioned that it is a bit of work to harvest the corn by hand in the fall (several people had reached out to local youth groups to handpick the corn, but timing did not work out), and most years the corn that was left on the stalks is no-longer harvestable during the spring due to deer browse and weather

Others other mentioned that the snow-fences can sometime cause excess moisture to build up which can be a problem for planting in the spring. Other participants mentioned that MnDOT's requirement that cornrows stay up until April 1st could also cause some time constraints for farmers:

I could have harvested three weeks ago (it was dry enough) but they want us to wait until April. This could make us run into some time constraints for farmers. It would be better for us if you move up the harvesting date to March 15 or March 1

6.2.5 Question 5: Was becoming a state vendor a problem for you?

In general, interviewees reported that the state vendor process was not an inconvenience for people who are computer literate with good access to internet and the necessary technology. However, for individuals who are not computer literate or do not have easy access this process is so difficult that it may become prohibitive and a major disincentive to participation. As one participant whom had problems with the form explained:

I am not computer savvy and if it were not for my wife, I would have given up and not participated altogether. My wife spent hours on the phone and on the computer trying to figure out how to submit the form. It was a big problem and I know several other people who had the same complaint. It can really turn people away. For example, I talked to my brother about it and he said he wouldn't do it because of the hassle of the form.

The same participant elaborated about how he felt saying: *"I'm doing MnDOT a favor, so why would I have to go through all the grief of the paperwork?"* Other participants said that they expected the paperwork because it was a government project. Other interviewees said that they think someone else at MnDOT filled out the form for them.

6.2.6 Question 6: Would you participate in the program again? Why or why not?

The majority of interview participants reported that yes, they would participate in the program again. In general, people gave the same reasons for continuing to participate in the program as they gave for beginning to participate in the program: it helps MnDOT; it helps the community, for their own convenience, the simplicity, and the financing:

The financing and the feeling of helping out: that there is something easy that I can do to make life easier.

Some participants had been setting up the snow-fences for 10 years straight. One participant said he continues with the program because the snow fencing works. Another person said that he likes participating because he gets recognition from community members:

We get a lot of compliments from people. Businessmen, nurses and teachers all use that road to get across town. They appreciate the clearer driving. They are especially grateful if there is a big storm.

Only one interview participant said that he might not participate the following year. He reported that when he originally spoke with a MnDOT representative he expected a certain amount of payment. However, in

the spring when people came to measure his fields they told him he would be paid less. He will not participate again unless he gets something in writing confirming the amount that he will be paid.

6.2.7 Question 7: What would you change about the program if you could? Do you have any suggestions for improving the program for next year?

Participants provided several suggestions for improving MnDOT's blowing-snow-control program:

- **Give participants the flexibility to experiment during non-corn years:** many snow-fence participants practice soy-corn crop rotation. They expressed that they would love to continue with the program if there is something helpful that they can do during their non-corn years. In addition, participants mentioned that additional people might be interest if MnDOT were flexible about the design of the cornrows and the amount of space between the cornrows and the road that is necessary.

- **Better coordination with youth groups**: several participants mentioned that they were willing to work with youth groups to come out and pick the corn but either the weather or scheduling did not work out.

- **Change the billing process/payment system:** some participants suggested changing the vendor form necessary for the payment system to make it easier for farmers. Some asked if there was any way to have the county pay the farms and then work with the state on the paperwork.

- **Increase payments:** while many people pointed out that they were not only participating in the program for the money, a few people mentioned that they "*would not complain*" if MnDOT increased the payment. Some also suggested that increasing the payment could incentive additional participation in the program.

- **Contracts:** as mentioned previously, another participant mentioned that he would only participate in the program again if he has a written contract saying how much he will be paid. This is because he was quoted one amount in the fall but was then quoted a different (smaller) amount in the spring.

- **Clarify Connection with University of Minnesota:** One participant mentioned that he read on the brochure that the University of Minnesota was involved with the blowing-snow-control program. However, when he asked someone he works with at the University about it the UMN contact had not heard about the program.

6.2.8 Question 8: Would you recommend participating in MnDOT's blowing-snow-control program to your neighbor? Why or why not?

In general, most interview participants reported that the would, or already do, recommend MnDOT's blowing-snow-control program to their neighbors. People said that they would tell neighbors that the program is easy and MnDOT is easy to work with. People also pointed out that seeing neighbors participate in the program is a major way of advertising the program once people see that it is effective:

Yes, other people have talked to me about it. They know me and see that I left up the corn and I tell them about it and that I think it is good. Also, that is how I learned about it in the first place- a neighbor had it and we saw that it did its job.

People said that they especially try to mention the program to people in the community that live near areas that always have blowing-snow problems.

6.2.9 Question 9: Do you have suggestions for how MnDOT could encourage non-participating landowners to participate in this program?

Many participants pointed out that one of the best way to encourage non-participating landowners to participate in the program was to simply talk to more people about it and have more information available about the program. Many people still do not know about the program. Some specific suggestions included:

- **Word-of-Mouth is very effective:** having a personal connection and conversation with someone recommending the blowing-snow-control program is the most effective means of getting the word out about the program and encouraging participation according to several interviewees. In addition, once MnDOT employees develop relationships with farmers it is significantly easier to get them to participate. For example, one participant mentioned that while he had heard about the program on the radio he would never have participated if someone had not stopped by his property to talk about the program with him personally,

- **Make sure people see snow-fences working:** as one interviewee explained,

  When you see it working in the neighborhood it makes a big difference. For example, a neighbor nearby that also lives on an S curve participated in the program last year and everyone saw it and was talking about how well it worked. Since then I have seen more snow-fences popping up in the neighborhood.

  People also mentioned that once people realize that it is easy to participate and that it does not take extra effort, it is easy to get them to participate.

- **Funding is an incentive:** while many people do not participate in the blowing-snow-control program

solely for the money, they also pointed out that they do not think people would participate for less money and offering more money might encourage more people to be interested.

- **Reach out to farmers in the spring:** speak with farmer in the spring when they are first planting. If you wait until August or September, it is already too late. Farmers need to know about the program and the amount of funding they receive early so that they can plan accordingly.

- **Target outreach to problem areas:** it is a good idea to reach out to people on roads that have a lot of blowing-snow-control program. One participant noticed that MnDOT already seems to be doing this and that it is helpful:

  On I69, there were some blowing-snow-control issues in the past, but I noticed this year many people are doing standing cornrows, so someone must be targeting them. That is a good idea.

- **Do more advertising:** some participants suggested doing mailings or advertising on the radio, farm magazine and local papers. One person suggested having someone from MnDOT go on a radio station to talk about the program in the morning or the afternoon. There are some agricultural programs that would be good for outreach but any of the local radio stations would effective.

CHAPTER 7: ASSESSMENT OF THE MARKET AND NON-MARKET VALUES OF SNOW-FENCE AND THE INTEREST OF THE PRIVATE SECTOR AND ORGANIZED GROUPS IN HARVESTING A VARIETY OF PRODUCTS FROM LIVING SNOW-FENCES

7.1 INTRODUCTION

This task provides MnDOT an opportunity to compare the costs and benefits of different types of snow-control methods considered either short term or longer-term options to address blowing-and-drifting snow problems. "Short term is categorized as 1 winter season of blowing-snow-control protection (Ex. Standing corn rows, bales, temporary orange snow fencing) that are seasonal in nature-erected in the fall and removed in the spring by the landowner/farm operator. Long-term agreements are categorized as rooted vegetation or structural snow fencing with concrete and/or sleeves embedded into the ground at a depth greater than 4 feet. These roots and footings cannot be easily erected and removed on an annual basis, thus these agreements fulfill a need for a long term commitment between MnDOT and the Landowner that lasts multiple years upward to 15."[13] Costs and benefits are calculated for both landowners and MnDOT taking into consideration the payments provided by MnDOT (and other agencies in the case of Living Snow-fences (LSF)) and the opportunities for landowners to harvest corn from standing corn rows and potentially harvest fruits, nuts, berries, decorative stems and other products from living snow-fences which contain those products.[14]

Part of the work on this task included gauging the interest of local groups (4-H, FFA and others) in hand harvesting corn from standing corn rows to generate funding for their activities. This would require an agreement with the landowner or farmer who plants the corn but there has already been some experience with this type of arrangement in the past. A survey of some of the potential groups was implemented and the results are reported in this chapter.

Whether to include harvestable crops in a living snow-fence would depend on the interest of a farmer or landowner or potentially leasing out the snow-fence for someone else to manage and a payment to the farmer or landowner responsible for the snow-fence. In previous work with farmers and landowners, there has been little interest in planting species that produce edible products in living snow-fences (Petersen, 1999). We present some of the options for harvestable crops for snow-fences and discuss the advantages and disadvantages of the different options. This information can be provided to farmers and landowners to help them decide on an option.

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[13] Dan Gullickson, MnDOT from Sept 21, 2016 e-mail correspondence to District Snow-fence Coordinators.
[14] For lands enrolled in CRP as part of the snow-fence establishment, the landowner is not allowed to harvest products except for personal use.

7.2 FARMER/LANDOWNER COSTS AND BENEFITS OF IMPLEMENTING SNOW-FENCE OPTIONS

We evaluated 4 options for landowners interested in establishing a snow-fence on their property or farming areas. Each option provides protection for a quarter mile (1,320 feet) of roadway so, in terms of impact on blowing-and-drifting snow issues, they cover the same area although the size of the area dedicated to the fence and snow catch vary from one option to another. It should also be noted that effectiveness of the fence may vary by type and age of fence. Following is a short description of the options evaluated. More detail on the options is provided in Appendix 3:

1) Standing corn rows, 50 feet in width, left standing after the rest of the corn has been harvested. We used an average MnDOT payment of $1,500 per acre of corn area left in the field for our calculations. We subtracted the costs of establishing the corn from the MnDOT payment to determine the landowner benefit. It is important to note that corn usually alternated with soybeans and thus corn rows might not be available every year leading to alternating years with and without coverage. Landowner is responsible for establishment and maintenance of corn rows;
2) Living snow-fence established with and without CRP where the snow catch area is cropped by the landowner or his tenant. The snow-fence area is 50 ft. wide and the snow catch area, for which the farmer is compensated by MnDOT, is 150 ft. wide. The fence area is 1.5 acre in size and the snow catch area is 4.5 acres in size. The landowner is responsible for establishment and maintenance with CRP;
3) Living snow-fence and snow catch area established with and without CRP where the snow catch area is planted in perennial grasses and wildflowers. The snow-fence area is 50 ft. wide and the snow catch area, for which the farmer is compensated by MnDOT, is 150 ft. wide. The fence area is 1.5 acre in size and the snow catch area is 4.5 acres in size. The full six acres is eligible for CRP payments. The landowner is responsible for establishment and maintenance with CRP; and
4) Structural Snow-fence. A semi-permanent 8’ tall flexible composite rail structural snow-fence with footings which on average cost $30 per lineal foot to install with installation being carried out by contractors. MnDOT pays $1 per lineal foot for structural fences as well as covering the costs of establishing the fences.
5) For all 4 options, we estimated the cost of a one-time lump sum easement or purchase payment for the land covered by each type of snow-fence and the associated snow catch area. Estimates of land value are based on current agricultural land value in Renville County. In this case, all establishment and maintenance costs would be borne by MnDOT.

Table 7.1 Landowner benefits associated with four 1,320-foot Snow-fence Options (Note: all options provide 1,320 feet of roadway protection)

Snow-fence Option		Current practice		Up-front payment	Purchase/Easement
	Acres taken out of production (a)	Annual payment (b)	Sum of annual payments for 15 years (c)	Present value of 15 payments @ 5% discount rate (d)	Lump-sum payment @$7,500 /acre[15] (e)
1) Standing corn rows – 1.5 acres (cost of planting corn deducted - $617/acre)	1.5	$1,325.50	$19,868	$13,748	$11,250
Per acre benefit (acres out of production)		**$883**	$13,245	$9,165	$7,500
2) Living Snow-fence - 1.5 acres snow-fence in CRP, 4.5 acres snow catch in crops	1.5	$938	$14,063	$9,731	$11,250
Per acre benefit (acres out of production)		**$625**	$9,375	$6,487	$7,500
Payment per option without CRP[16]	1.5	$563	$8,438	$6,934	$11,250
Per acre benefit without CRP		**$375**	$5,625	$4,622	$7,500
3) Living Snow-fence – 1.5-acre snow-fence plus 4.5 acres snow catch all in CRP	6.0	$2,625	$39,375	$27,247	$45,000
Per acre benefit (acres out of production)		**$438**	$6,563	$4,541	$7,500
Payment per option without CRP[2]	6.0	$1,125	$16,875	$11,677	$45,000
Per acre benefit without CRP		**$188**	$2,813	$1,946	$7,500
4) Structural snow-fence – 0.75 acre	0.75	$1,320	$19,800	$13,701	$5,625
Per acre benefit (acres out of production)		**$1,760**	$26,400	$18,268	$7,500

[15] This would be a one-time payment for purchase or easement paid to the landowner and MnDOT would cover all costs of establishment and maintenance for the snow-fence. Farmland prices in Renville County currently $7,000 - $8,000 per acre depending on the quality of the soil.
[16] The annual payment per option without CRP is for the entire practice not a per acre calculation.

UMN Extension estimates direct costs of corn production at $617 per acre for 2017. MnDOT covers the costs of establishing the fence for Living Snow-fences and Structural Snow-fences.

Tables 7.1 and 7.2 provide a summary of the results of the analysis. Table 1 is a summary of the net benefits to farmers who implement snow-fence options and Table 2 is a summary of the costs of the different options to MnDOT. Each table presents: a) the annual costs and/or benefits associated with each option; b) the total MnDOT expenditures; c) landowner benefits over a 15-year contract period; and d) a calculation of what an upfront payment might be if MnDOT were to offer that option to landowners who may be interested in a single payment for the fence (from MnDOT, CRP payments would remain annual) instead of the normal annual payments.

Table 1 has six columns with the specific option listed in the first column and 5 columns (a-e) showing the results of the analysis of benefits to farmer landowners under the different options. Below is an explanation for each column:

a) **Acres taken out of production**: This is the number of acres taken out of production to establish the snow-fence and, in option 3, the snow catch area put into CRP. In options 2 and 3, a total of six acres are impacted but in option 2, 1.5 acres are dedicated to the snow-fence and received both MnDOT and CRP payments while the remaining 4.5 acres receive a payment from MnDOT but no CRP payment and can be cropped so only 1.5 acres are taken out of production. In option 3, 1.5 acres are dedicated to the snow-fence and the 4.5 acres used as snow catch also receive a CRP payment, so they cannot be cropped. In option 3 a total of 6 acres are taken out of production.
b) **Annual payment**: This is the payment that the landowner will receive on an annual basis. It includes both the MnDOT payments and the CRP payments. The MnDOT payment of $155 for maintenance is not included in the payments since that is an expense and not a net benefit for the landowner. The annual payment is expressed as a payment for the snow-fence and snow catch area and also the equivalent per acre payment.
c) **Sum of annual payments for 15 years:** This is simply the sum of the annual payments paid over a 15-year period and represents the total amount of funding the landowner would receive over 15 years.
d) **Present value of 15 payments at a 5% discount rate**: This represents the value of an upfront payment at the beginning of the 15-year period. This figure takes the 15 individual annual payments and discounts them back to the first year of the contract.
e) **Purchase/easement one-time payment:** this represents the payment that mean that would make to purchase the land or to purchase an easement for a snow-fence. In this case MnDOT would be responsible for the establishment and maintenance of the snow-fence. For this calculation $7,500 was used. This was based on the current value of $7,000-$8,000 per acre for farmland in Renville County.

Table 7.1 above provides a summary of landowner options the benefits of each option. Options 1 and 2 require taking 1.5 acres out of production, while option 3, which includes a snow catch area in CRP, would take out 6 acres. Although that is a larger area taken out of production, the snow-fence and snow catch

area provides a guaranteed annual return per acre of almost $600 when land rents run from $250-$300 and are expected to decline in the future. For some landowners that might be a good use of some land in the face of declining prices for agricultural commodities and who can lock in a guaranteed payment for a portion of their acreage.

The benefit of a structural snow-fence has the largest per acre benefit because of the small footprint (25 feet wide) and the generous payment but, as is evident from MnDOT costs (see Table 2), it is the most expensive option for MnDOT to address blowing-and-drifting snow issues.

7.3 OTHER FARMER/LANDOWNER CONSIDERATIONS

When making decisions about snow-fence adoption, other considerations may influence a landowner's decision. These include but are not limited to things like taxes, impact on government payments and insurance programs, and the impact the fence may have on the neighboring community. These are all considerations that need to be understood and explained when landowners are approached to promote the installation of a blowing-and-drifting snow-control option.

7.3.1 Taxes

A landowner will have to pay taxes on the income received from MnDOT and CRP as a land rental payment. If an easement is purchased or the land is condemned, landowners are guaranteed a fair price decided by the County land assessor and the payment would be subject to capital gains tax treatment. If a lump sum payment were offered instead of annual payments that could potentially result in pushing a landowner into a higher tax bracket for that year but that would be different for every landowner.

7.3.2 Impact on government payments or insurance payments

Any land taken out of production would not be eligible for commodity crop insurance or subsidy programs as it would no longer be cropped. But, if the land is put back into commodity crops following the termination of the snow-fence contract, the land can be planted back to commodity crops and would be eligible for all government programs. There would be no loss of future eligibility for having taken the land out of crops for a period of time.[17]

[17] Kevin Beekman-Farm Service Agency County Executive Director. Personal communication.

7.3.3 Impact on community

We have heard from farmers that have installed standing corn rows that their neighbors have thanked them for doing so and this may influence decisions to implement snow-fences. A social rather than financial consideration but potentially an important incentive for some.

7.3.4 Transitioning from standing corn rows to a longer-term solution

Standing corn rows have been the option that most farmers choose because of the ease of adoption and the lack of a longer-term commitment. Nonetheless, in most cases, farmers are paying $617/acre to plant corn at current (2017) prices and often are not able to harvest the corn or must do it in the spring, which is inconvenient for a number of reasons. For those farmers who adopt standing corn rows and continue to implement them, the planting costs represent a cost that could be avoided if they were to implement a longer-term option (living snow-fence, structural snow-fence, etc.). This would be an argument for farmers to transition to one of the longer term and more effective solutions.

7.4 MNDOT COSTS FOR IMPLEMENTING SNOW-FENCE OPTIONS

Table 7.2 provides a comparison of the costs of different snow-fence options to MnDOT and reflects only payments made by MnDOT to the landowner including the costs MnDOT incurs when installing living and structural snow-fences. For example, in options 2 and 3 that include CRP payments, the CRP payments are not included in the analysis since MnDOT does not make the payment to the landowner, so the payment is not a cost to MnDOT.

Looking at total costs over a 15-year period including the cost of installing the fence demonstrates some fairly significant differences between options. Although the annual payment for a structural snow-fence is not as high as an either the standing corn rows or living snow-fence with the snow catch in CRP. The high cost of installation makes the total cost almost double the cost of the next most costly option in terms of total cost.

There are significant differences between the benefits to farmers and the costs to landowners of the different snow-fence options. There are several ways this information might be used:

- Due to the permanence and additional environmental benefits provided by living snow-fences, MnDOT might consider raising the annual payment to farmers/landowners who establish LSF's to at least the same annual payment provided for standing corn rows as long as cost savings from the fence justify a higher payment.
- If MnDOT is interested in the cost efficiency of the snow-fences installed, preference might be given to the LSF and SCR options which does seem to be current practice.

Table 7.2 MnDOT costs associated with four different 1,320-foot Snow-fence Options

Snow-fence Option	Present value @ 5% of 15 annual payments + cost of fence	Annual payment	Total of annual payments + fence
1) Standing corn rows – 1.5 acres	$23,354	$2,250	$33,750
2) Snow-fence - 1.5 acres snow-fence in CRP, 4.5 acres snow catch in crops	$9,347	$795	$13,020
3) Snow-fence – 1.5 snow-fence plus 4.5 acres snow catch all in CRP	$22,425	$2,055	$31,920
4) Structural snow-fence – 0.75 acre	$53,301	$1,320	$59,400

Note: All options in the table will provide for 1,320 feet of roadway protection. This table does not include costs borne by the CRP program or by farmers. These are all MnDOT expenses.

All of the information in Tables 7.1 and 7.2 including additional detail has been incorporated into an Excel spreadsheet that will be provided as part of the final report.

7.5 GAUGING THE INTEREST OF 4-H AND FFA CHAPTERS IN HAND HARVESTING CORN FROM STANDING CORN ROWS

A survey was prepared on line and invitations to participate distributed to both 4-H and FFA chapters in the state through their state level coordinating organizations. 73 Surveys were filled out on-line with 44 from 4-H chapters, 28 from FFA chapters and one unspecified. The distribution of the answers was good with a few counties unrepresented but with a good coverage where problem blowing-and-drifting snow areas have been identified by MnDOT. Generally, the response was positive with interest shown by the groups in hand harvesting corn as income generating option to support local chapters of 4-H and FFA. A presentation including the survey questions, methods and results is provided as Appendix 4 to this report.

The results and list of organizations interested provide a good source of information for working with farmers and 4-H and FFA groups on harvesting corn from SCR's and providing community support and education about the MnDOT program.

7.6 PLANTING AND HARVESTING ALTERNATIVE PRODUCTS FROM SNOW-FENCES

Several options for including harvestable products in snow-fences have been discussed over the years starting in the 90's. Producing fruits, nuts, decorative woody florals (stems such as willows and dogwoods used by the floral industry), pollinator habitat are some of the options that have been suggested. In a consultant's report prepared for MnDOT based on focus group interviews held in St. Cloud, Crookston and Redwood Falls in November of 1998 with a group structured to compare landowners vs. renters, high value crop vs. low value crop and dairy farmers vs. non-dairy farmers, the authors concluded that , "The farmers who attended and participated in the focus groups were not in favor of planting and harvesting alternative crops in the land set-aside for a snow-fence" (Petersen, 1999)(See Appendix 1).

Despite the fact that there has been little interest demonstrated in alternative products in land occupied by snow-fences, it may still be an interesting and viable option for some farmers and landowners and may be something that MnDOT could provide information about should any landowners be interested. A relatively small sample of farmers/landowners has been surveyed about their interests in alternatives and there may still be others who may be interested in alternative crops and income generating options. Farmers/landowners with smaller landholdings and more intensive and labor-intensive management operations may be able to incorporate alternative production options on their farms if the alternative is compatible with their current farming system. Compatibility of an alternative crop with the current farming practices was listed as one of the constraints to adopting alternative crops in a snow-fence. Providing information on alternatives to farmers/landowners may be helpful for some potential adopters of snow-fences but may not be an important incentive for most.

Following is a list and then a discussion of some of the options farmers might have to produce food and marketable products from snow-fences. There may be other options, but these are the options that have received the greatest attention from research and also marketing:

- Decorative woody florals
- Hazelnuts
- Aronia Berry
- Elderberry

Note: Most of the information for Elderberry, Aronia and Hazelnuts comes from, "A Landowners Guide to Perennial Crop Options", (Jensen, 2014) which is an excellent source of information and references to additional information and organizations working on the production and marketing of the different options. The financial analyses are preliminary but do serve as a reference to the information that is currently available on the financial aspects of production of the different options. Appendix 2 provides links to a number of tools that can be used for analyzing perennial cropping options.

7.6.1 Decorative woody florals

Decorative woody florals are stems, and stems with flowers, of woody species that are used in the floral industry and command good prices in the market if farmers can identify markets for them. Conversations with wholesalers in the Twin City metropolitan area have indicated that wholesale buyers often will purchase DWF's from individuals if they are delivered to their warehouses. A farmer cooperative in Nebraska (nebraskawoodyflorals.com) markets their woody florals from a website and charges prices that appear to provide good income to producers. In a Grower's Guide published in 2007 by the Nebraska Forest Service, the authors calculated that, "some cultivars can generate gross incomes ranging from $8,843 to $16,308 per acre ... beginning two to three years after planting" (Meyer, et. al., 2007). In that same study, net income per acre depending on species and spacing varied between $4,435 and $12,390 per acre. In the first two years, a farmer/landowner would incur costs of establishment of between $530 and $1,114 per acre.

The species used for floral markets in Nebraska include Flame willow, Scarlet Curls willow, Curly willow, Asian Pussy willow, Japan Fantail willow and Red Twig and Cardinal Dogwood. Species should be selected based on local varieties and market demand.

Figure 7.1 Decorative Florals Photo Credit: Meyer (2007)

The potential to generate good income from woody florals is attractive and, presented with the option and the potential earnings, cultivation of woody floral s may generate interest. More recently, the Nebraskawoodyflorals.com website is advertising woody florals with current prices from 2-10 times higher than the prices quoted in the 2007 publication while the Consumer Price Index has only increased by 0.16. Another advantage for farmers is the fact that DWF's are harvested in the winter so would not likely interfere with other farming activities. If markets are available and farmers are willing to provide the labor or hire labor to manage plantings, this appears to be a good opportunity for farmers/landowners to combine windbreaks and woody floral production.

7.6.2 Hazelnuts

Hazelnuts have been a subject of research for the last 15-20 years and progress is being made but researchers suggest that we may still be several years away from having planting stock for which we can predict yields and performance with some degree of confidence. They are an attractive option due to the wide variety of markets available for different scales of production. Farmer's markets, stands and local shops might be able to absorb small quantities as growers are getting started but there is also interest in moving hazelnuts into a commercial scale as whole nuts, cracked nuts, hazelnut meal and even hazelnut oil as the base for a renewable fuel.

The American Hazelnut is native to the Minnesota but most the planting is being done with hybrids of American hazelnut (*Corylus americana*), beaked hazelnut (*Corylus cornuta*), and the European hazelnut, (*Corylus avellana*) which were developed in Minnesota and which are cold hardy here and resistant to Eastern Filbert Blight, a major disease in hazelnuts.

Jensen (2014) developed a financial analysis for hazelnuts. As with aronia berry and elderberry, establishment costs are high at $7,000 per acre. When an analysis was carried out for a 20-year period, hazelnuts were not profitable, and the analysis showed a loss. It should be noted that this was only a preliminary analysis and improvements in planting stock and propagation methods as well as improved quality and marketing will help lower costs and move hazelnuts towards being a profitable alternative for farmers and landowners.

Figure 7.2 Hazelnuts

7.6.3 Aronia berry

Aronia (*Photinia melanocarpa*) berry, also known as chokeberry for good reasons is another option for farmers and landowners. The berry is bitter and has and astringent flavor but is sought after for its' high anti-oxidant content. The plant is relatively rugged and holds up well to picking and transporting. (Jensen, 2014). There is a market for aronia berry as an additive to other fruit juices and there are commercial producers in Minnesota, Wisconsin and Iowa, some producing for their own use and sale while others sell into larger markets. There is a North American Aronia Cooperative (NAAC) in the North Central region of the US and that cooperative would be a source of information, expertise and markets. Another organization, the Midwest Aronia Association (http://www.midwestaronia.org/) would be another source of information.

Figure 7.3 Aronia Berry Source: Photos from Jensen (2014)

Establishment costs at $6,400 for this system are relatively high and might be a constraint to adoption unless those costs were covered by payments from MnDOT or some other incentives program. The financial analysis prepared by Jensen (2014) showed that net income turned positive in the 4th year of production while the breakeven point (when total income is greater than total costs) occurred in the 8th year of production. The average annual income over a 20-year period was $1,930/acre.

This might be an option that farmers/landowners might consider as it can be mechanized and might be more easily managed as an alternative crop in a snow-fence area. Nonetheless, the high establishment costs and breakeven point in the 8th year might deter some farmers unless they were able to make the investment, as their average annual return is high.

7.6.4 American Elderberry

Elderberry (*Sambucus Canadensis*) is a relatively well-known fruit bearing plant that occurs in the wild in Minnesota. Improved cultivars are available that have been selected for fruit production. Unlike Aronia, the elderberry is sweet, can be harvested from the plant, and eaten as is. There are two potential outlets

for elderberry production in Minnesota, River Hills Harvest (http://riverhillsharvest. com/) and the Minnesota Elderberry Cooperative (http://www.minnesota-elderberry. coop/).

Figure 7.4 American Elderberry Source: Photos from Jensen (2014)

It is expensive to establish an elderberry planting with costs estimated by Jensen (2014) at $5,200 per acre and requiring a weed barrier plus mulch and irrigation. Because there are not options for mechanized harvest, the harvest is done by hand and may require more than one pass as the clusters ripen. In the Jensen analysis, a positive net return was generated in the 6th year after planting but the breakeven point (when cumulative returns equal cumulative expenses) not occurring until year 13. The system generates a total profit over 20 years with an average annual return of $493 per acre.

Because of the high costs of establishment and harvest and the breakeven point not occurring until year 13, this system might not be an attractive option for farmers, as they would also have to harvest or hire labor to harvest the berries.

7.7 SUMMARY

The review of some of the more promising options for alternative income generating crops for including in snow-fence establishment has demonstrated some of the drawbacks but also some potential opportunities. High establishment costs, manual harvesting, generally labor-intensive cultivation and relatively new and underdeveloped markets may make some alternatives less attractive to farmers and landowners establishing a snow-fence. Nonetheless, some potential opportunities could be explored especially when subsidies/incentives are provided to cover the initial higher costs of establishment and maintenance of plantings and may be a way for farmers to generate income from a planting until they reach the breakeven point when the planting becomes profitable.

Of the alternative crops reviewed, the decorative woody floral option seems to offer the greatest opportunities if markets can be identified for the output from those systems. There are several options that can be presented to farmers and landowners but, in the end, it is ultimately their decision to adopt them or not.

CHAPTER 8: RECOMMENDATIONS

8.1 LANDOWNER AND RENTER KNOWLEDGE, ATTITUDES, AND PRACTICES RESEARCH

The first, and second-round KAP studies highlighted an important gap in knowledge relating to the perceptions and motivations of landowners. Though there were many questions included in this survey relating to landowner perceptions and motivations, it is important to remember that the results do not directly represent actual landowner opinions. Rather, the results from this survey merely illustrate MnDOT employees' perceptions about landowners' opinions. Thus, MnDOT should not use this information to make conclusions or programmatic decisions related to actual landowner opinions.

The survey results do reveal that MnDOT tends to naturally orient toward financial and technical approaches, such as easements and incentives. However, past studies on landowner attitudes and practices have shown that there may be other, perhaps more effective, methods of obtaining landowner interest in addition to the approaches that MnDOT is currently using. Landowners may have other influential motivations relating to issues of safety, legacy, or social conscience.

At this point, the main blowing-snow-control challenges faced by MnDOT are not technical, but rather they are related to the social problem of adoption. Understanding the complex social dimensions of blowing-snow-control is a necessary next step. Further research on landowner perceptions and motivations, in the form of a comprehensive and rigorous survey, will help MnDOT design new solutions and more effectively reach out to landowners. Key issues, such as differences in land ownership (renters versus owner operators) and their impacts on adoption, should be explored.

8.2 PROVIDE ADMINISTRATIVE GUIDANCE AT CENTRAL AND DISTRICT LEVELS ON RESPONSIBILITIES FOR SNOW-CONTROL PROGRAM IN THE DISTRICTS

Initial group meetings and KAP studies highlighted a lack of clear understanding of MnDOT staff on who within the district was responsible for snow-control measures at both the program delivery and maintenance levels. As MnDOT moves forward with snow-control measures, it will be important to ensure that district staff, both program delivery and maintenance, understand how each unit can address snow-control issues. Program delivery through design of new and refurbishing of old roadways and maintenance through promoting blowing-and-drifting-snow-control measures. Training agendas and materials are available for providing information on responsibilities and options for snow-control for both groups.

8.3 PROVIDE TRAINING ON RESPONSIBILITIES, SNOW-CONTROL METHODS AND TOOLS AND INTERACTING WITH LANDOWNERS

Initial meetings and the KAP survey demonstrated a lack of knowledge of responsibilities for methods to control, and tools available to assess and address blowing-and-drifting snow-control problems. MnDOT staff also requested training on how to interact with landowners when providing information promoting snow-control measures. Based on the KAP meetings and surveys as well as recommendations and

requests by MnDOT staff, a training program was designed to address the knowledge needs of MnDOT staff. We recommend that a similar training program should be designed for other MnDOT districts but that training needs be assessed with a KAP-based methodology. With the experience now available, the KAP process for evaluating training needs and assessing uptake after training can be streamlined and applied in other MnDOT districts in the state. We do recommend that an assessment process be undertaken prior to training due to the differences between farmers and MnDOT districts in the state.

This project developed a series of training and promotional materials for training and promotion of blowing-and-drifting snow-control measures in other parts of the state with the modifications required based on the KAP assessment and any follow-up research on farmers knowledge, attitudes, and practices.

8.4 ASSIGN SNOW-CONTROL PROMOTERS AT DISTRICT LEVEL

It was evident through our interaction with district MnDOT staff that there was not a clear identification or assignment of responsibilities for the promotion of blowing-and-drifting snow promotional activities. The responsibilities, in practice, have been taken on by maintenance staff who have taken an interest in promoting blowing-and-drifting snow-control measures with landowners and have done so on a voluntary basis, often with great success because of their connections with the community. Even though those individuals have taken on the promotional activities, there is no existing incentive for them to do so other than the recognition they may receive from MnDOT or the community even though the promotion requires additional time and effort. We were also able to observe that often, those promoters were successful due to their personalities or connections within the farming communities, and to guarantee greater success in promotional efforts, it would be helpful to identify those individuals with the greatest interest and ability to take on promotional activities. In the case of this research, those individuals voluntarily came forward following our training and discussions.

We recommend that, through some mechanism, as occurred in our training, MnDOT identify individuals interested in working with landowners and assign them promotional activities with an appropriate compensation for their efforts. We understand that MnDOT must act under guidelines related to hours worked, overtime available and other restrictions. Having a person designated as a promoter or as a "snow-fence ambassador," might allow MnDOT to provide compensation and resources necessary for promotion to those individuals selected to take on responsibilities.

8.5 REVIEW AND UPDATE INCENTIVES FOR FARMERS ADOPTING CONTROL MEASURES

The review of the current payments to farmers and the costs and benefits of different snow-control to farmers and MnDOT suggest some areas where the payments might be modified to promote greater adoption of more permanent snow-control measures. If the recommended research into farmer knowledge, attitudes, and practices is undertaken, it will provide an opportunity to gauge how farmers might respond to different payment options and amounts. This would allow MnDOT to consider options that may be more cost effective in promoting increased adoption of blowing-and-drifting snow measures, increasing public safety and lowering overall maintenance costs on MnDOT maintained roadways.

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APPENDIX A:
DESCRIPTION OF STATE SNOW-FENCE PROGRAMS

COLORADO

Most snow-fences in Colorado are living snow-fences. The State Forest Service supplies all trees for LSFs in Colorado. Currently, the Colorado State Forest Service Seedling Tree Program provides landowners with highly subsidized seedling trees to encourage landowners to plant windbreaks and living snow-fences on their property (Williamson & Volk, 2009). The goals of this program are to protect roadways and livestock, provide wildlife habitat, and reduce erosion.

While Colorado's LSF program once operated at the state level, it is now maintained through local conservation districts and extension offices in eight counties. When the snow-fence program was occurring at the statewide level, over 300 living snow-fences were planted and maintained on both county and state highways. Factors cited as having contributed to success of adoption of the statewide program include coordination at the local level and cooperation between project partners including the DOT and the forest service. In addition, many of these fences were installed as demo projects, which introduced new technologies. One thing that may have also helped the statewide program in the long run was public education on the benefits of living snow-fences that exist beyond snow-control (Williamson and Volk 2009). A recent study published in May 2015 details an evaluation of the snow-fence program and provides recommendations for future programs (Sundstrom, 2015).

In Colorado, there are currently two USDA programs that landowners can use to defray the cost of installing and maintaining living snow-fences. The Continuous CRP program through the Farm Services Agency (FSA) will pay the landowners an annual rental rate for 15 years on the acres removed from farming production. FSA will also pay a percentage of the installation costs. The Environmental Quality Incentives Program (EQIP) through the NRCS will also pay a percentage of installation costs and is used on areas that have not been farmed like rangeland. Both programs have eligibility requirements that must be met.

Outreach

In many states, local conservation districts work with the DOT to identify stretches of road that have problems with snow drifts. In Colorado, the most effective form of snow-fence program outreach involves directly contacting landowners adjacent to road areas that need protection from blowing-snow and informing them about the Federal cost share programs available to them for snow-fences.

District conservationists are already familiar with local landowners and can make direct contact with potential participants. When district staff reach out to landowners, they explain the benefits to the roadway, wildlife habitat and soil preservation. Landowners that choose to participate see benefits to themselves and community. Some of the fences are multipurpose and act as livestock barriers. In addition, plant species for snow-fences in Colorado are often selected for their wildlife value (Plum and Choke Cherry). Landowners who do not participate often refrain from installing fencing because LSFs can act as obstacles and break up fields into smaller parcels. They can also cause losses of production and it is especially difficult to encourage participation when commodity prices are high.

IDAHO

ITD District 6 in in Southern Idaho only uses snow-fences due to the region's topography and climate that makes it susceptible to blowing-snow and dust. The state typically uses a steel permanent snow-fence that is produced locally by a company called perma-rail (www.snowfence.com). The ITD reports that the fences are extremely durable and long lasting. The fencing is also easy to move, easy to repair and has flexible heights. Prior to building snow-fence, ITD District 6 spent many years fighting drifting snow in several problem areas in the region. All the locations in the District with blowing-snow problems are retained in GIS format records. When selecting locations for snow-fence construction the most important factor for ITD District 6 is long-term permanent access

Currently almost all of Idaho's snow-fences are on public land managed by the Bureau of Land Management (BLM) because landowners typically do not want the fences in their fields. While ITD Region 6 has attempted to reach out to landowners about building fencing on private farm ground, most of these attempts have not been successful. Farmers in the region of Idaho use irrigation pivots that cannot run through a snow-fence. In addition, while farmers are typically very happy to have any extra moisture fencing or trenching (discussed below) can capture because of the controlled drifting, they will not allow access to their fields after a minimum depth of snow is present to minimize compaction effects on fall-sprouted crops. The state only has one snow-fence that they have been able to locate on private land. In this case, the land's value for crops is limited due to rocky, infertile terrain. The landowner uses the area for pasture and the fences do not negatively affect the cattle. In the past ITD also experimented with temporary straw bales snow-fence on farmland. One such fence stayed in place for two years and successfully prevented blowing-snow problems on the nearby road.

Typically, if ITD has a problem area but cannot fit a snow-fence on available public land they will either build snow berms using snow cats and existing snow or use a caterpillar to make a snow trench. ITD has found that any trenching no matter the proximity to the road will prevent some snowdrift. Three districts in southern Idaho (4, 5 & 6) currently have snow cats as part of their winter fleet. Throughout the season ITD, staff will re-open trenches and re-form snow berms as needed. In the past ITD also tried paying landowners to install hay bales as snow-fences. The bales were effective but removing them proved difficult.

Outreach

Typically, local operators talk to people about forming snow berm and trenches on or near their property. There is no contract but rather the agreement is done "on a handshake." Most field staff are from the communities and already have relationships with landowners, which makes it easier to reach out to them.

Iowa

The flat agricultural terrain found in most of the state makes Iowa's highways highly susceptible to blowing-snowdrifts and an ideal location for snow-fences. IDOT has an annual budget of $130,000 set aside for snow-fences on state and interstate roads. Iowa's standing cornrow program has been in operation for about 12 years and pays landowners to maintain several rows of corn along state roadways in the winter. IDOT pays a flat rate of $5 per bushel of corn and uses the following formula to calculate landowner payments:

Total Acreage *Bushels/Acre*$5/Bushel Landowner Payment

Aside from receiving slightly more than the market price for the corn, farmers are also able to harvest the crop in the spring. With about 70 contracts annually, the standing cornrows are Iowa's most popular snow-fence. Once in the program, farmers typically renew their contracts.

Iowa also has 5-year contracts with landowners to install permanent snow fencing on their property. For structural snow-fences, IDOT pays landowners $1 per linear foot, installs the fences and repairs them as they are damaged. The state currently has contracts with 17 landowners for these permanent wooden fences. Iowa will also pay landowners to set aside a portion of their property for planting living snow-fences. IDOT will plant the snow-fences and landowners receive payments through the federal Conservation Reserve Program (CRP). However, living snow-fences take relatively more land out of production and are IDOT's least popular snow-fence option.

Outreach

Once IDOT supervisors identify problem areas on state highways, field staff goes out to talk directly to landowners. In rural areas, many of IDOT's field staff are from the local area and are farmers or have worked for farmers in the past. This makes it easier for them to reach out to local landowners as they often have pre-existing relationships and can explain the benefits of the program from the perspective of a fellow farmer.

For the standing cornrow program, field staff contact landowners early in the growing season to give them time to make plans and consider options. According to IDOT field staff, getting a snow-fence program started in a community initially requires a lot of "leg work" and networking with landowners that are open to new ideas. However, once a few landowners take up the program their neighbors see the positive benefits and the program spreads faster. IDOT also publishes information on its website and has a brochure that staff provide to landowners. This year IDOT also conducted a media campaign on the radio, twitter and Facebook that seemed to be effective in reaching new landowners.

In the future IDOT would like to continue to expand its snow-fence program to include more landowners.

Illinois

While Illinois does not have a state snow-fence program, several counties in the state independently utilize snow-fences as a winter roadway management tool. Funding for these programs come from county budgets.

For example, the McHenry County Division of Transportation (McDOT) of Northeast Illinois installs temporary snow-fence for about seven straight miles on county roads that have problems with drifting snow. McDOT prioritizes temporary snow-fences over other options to avoid interfering with local farming operations. McDOT obtains verbal permission from landowners to install and remove the fencing every season. No contracts are involved, and the landowners are not paid to have the fencing on their property. Landowners participate in the temporary snow-fence program because they are citizens of the county and see the benefits that the fences have on their property and in the community. Of the 28 landowners that McDOT has called this year for the temporary snow-fences, only one has not given permission to install the fencing on his property.

McDOT previously had a program to annually purchase standing rows of corn from local landowners to serve as snow-fences on portions of the county's highway with a history of blowing-and-drifting snow. Payment for landowners was calculated based upon the high estimates of the per bushel price of corn as set by the Illinois Farm Bureau or the Commodity Credit Corporation. Landowners were also allowed to hand-harvest any corn left on the stalks. However, local landowners were uninterested in the program.

Over the past three winters, McDOT has also asked a few landowners to leave about 12 inches of corn stubble in the fall to serve as a barrier to blowing-snow. The landowners are not paid for this service and it is organized via a verbal agreement or "friendship deal" rather than a formal contract. In the spring, the stubble does not cause any inconvenience or require any extra effort on the part of the landowner. Based upon observation, McDOT estimates that the stubble stops about 30-40% of the snow. However, the corn stubble loses efficiency with increased snowfall and barriers are no longer effective once the snow height reaches the top of the stubble.

Outreach

In the case of McDOT, outreach is done through one-on-one conversations between DOT staff and landowners. McDOT also had a brochure for the standing cornrow program. To increase participation in the future the McDOT representative suggested conducting more public awareness campaigns about the benefits of snow fencing.

MAINE

MaineDOT uses permanent structures and LSFs in the northern portion of the state. MaineDOT typically plants evergreen trees along highways on the edge of the right-of-way or just over the right-of-way. Landowners sign a permission form to allow MaineDOT to place snow-fences on private property, but no money is exchanged. However, this is not very common, and the DOT only has these agreements with about half a dozen landowners. In the past, MaineDOT also plowed "snow roads" which were roads plowed into fields to catch snow. However, this practice allowed frost to penetrate deeper into the soil in the areas that had been plowed which negatively affected crops. Snow roads are no longer used for this reason.

MICHIGAN

Michigan has no formal snow-fence program and snow fencing is not a large part of winter operations. However, local districts do use temporary snow-fences on an "as needed basis". All funding for snow-fences comes from normal operations budgets. Temporary snow-fences made from orange plastic are the most commonly used snow-fences in Michigan and these fences are very rarely placed on private property. In the limited instances when temporary fencing is installed on private property, it is usually because local MDOT staff know the landowner. Landowners typically enter into an unofficial agreement with MDOT staff to put the fence on their property and no money or contracts are exchanged. MDOT does not have any statewide recommendations regarding snow-fences and these uncommon unofficial agreements are neither condoned nor discouraged by the DOT.

MINNESOTA

Minnesota's topography and climate as well as the agricultural landscape in the southern portion of the state make it an ideal site for snow-fences (Shulski & Seeley, 2002). The Minnesota Department of Transportation (MnDOT) has identified 3,700 snow problem sites that would benefit from snow fencing in the state. Today only about 2% of the identified problem areas in the state have been addressed (Wyatt, et al. 2015).

Minnesota typically utilizes permanent snow-fences in areas that will not support living snow-fences due to local herbicide practices, drainage tile lines, poor soil conditions including pH or salinity, or deer browse. In Minnesota these permanent structures are typically made of synthetic rail, wood, or steel posts. When placing these fences on private property MnDOT will either acquire an easement or enter into a contractual agreement with local landowners (MnDOT, 2015).

When possible, MnDOT prefers to utilize living snow-fences due to their relative high return on investment (CTS, 2015). These LSFs can be in the form of twin shrub rows or deciduous trees. Shrub snow-fences are typically smaller than trees but can tolerate many of the drier conditions that exist in Western Minnesota. MnDOT has also noted that seeding native grasses in snow-fences' snow storage area and beyond provides nesting bird habitat (MnDOT, 2015). MnDOT establishes LSF contracts with landowners to establish the fences on their property. Federal funding from the Farm Service Agency

such as the conservation reserve program (CRP), the Environmental Quality Incentives Program (EQIP) and others will also help farmers pay for the installation and maintenance of LSFs in Minnesota (Wyatt et al, 2015).

Finally, MnDOT will also annually purchase-standing cornrows in areas of the state that are near highways that routinely experience blowing-and-drifting snow. For standing cornrows, MnDOT pays landowners on a per acre basis and utilizing the University of Minnesota's cost-benefit tool to justify the investment (payments using this tool average $1000 per acre). In the past, landowners were paid on a per acre basis and payment is $1.50 above the market price for the cornrows. Landowners typically leave up 6-12 rows and the ear corn can be picked by hand or by youth or adult community groups (MnDOT, 2015).

MnDOT has found that snow-fence provides a high return on investment of $14 for every $1 spent. Despite their benefits, snow-fences make up a relatively small portion of MnDOT's annual budget. For example, in 2011, MnDOT paid a total of $50,974 for LSF contracts and $42,786 for standing cornrow contracts to 86 landowners in the state. In comparison MnDOT's 2011 budget for snow and ice removal was $81,085,500 meaning that only about 0.12% of the budget was spent on payments to landowners for LSFs and cornrow fences (Wyatt et al. 2012).

MONTANA

MDT utilizes snow-fences in areas with blowing-and-drifting snow issues. During construction projects for new or existing roads, MDT will purchase the land around the roads to install fences if there is a possibility that drifting snow will be an issue in the future. Funding for these purchases as well as the fences themselves come from federal roadway funding during construction projects. For snow-fences installed outside of highway construction projects MDT must use state funding. If a stretch of highway is experiencing drifting snow problems and there is no construction project scheduled, the MDT maintenance department will negotiate with local landowners to install snow fencing on their property. MDT typically uses large wooden structural snow-fences although they have also experimented with other materials. MDT also has arrangements with local building and flooring businesses to maintain the fences for free. These businesses maintain the fences and sell the old reclaimed weathered wood for furniture.

Outreach

Landowner outreach is extremely targeted and focuses upon problem areas around the state. MDT will negotiate to accommodate landowner preferences but typically takes up yearly leases with landowners and pays the rental value for the property. Landowners are typically willing to help because they have seen the snow-control problems on the road and recognize that the fences improve local road safety. In addition, landowners in Montana often like the snow-fences because they retain more moisture on their property.

NEW HAMPSHIRE

During the winter, NHDOT installs temporary wooden snow-fences on local landowners' property, on highway land, and on bridges. NHDOT has no extra budget for snow-fences but rather the materials and maintenance come out of normal district budgets.

Outreach

When NHDOT is interested in installing a temporary snow-fence on private property, NHDOT staff typically reaches out to landowners by going to their homes, knocking on their front door, and explaining what they want to do and the benefits that the fence will provide. 90% of the landowners contacted in this way allow the temporary fencing to be installed on their property. There are no formal contracts in this process and no money is exchanged for the service but rather NHDOT simply obtains verbal permission from the landowner.

New York

Several different transportation authorities independently implement snow-fence programs throughout New York State. The New York Thruway Authority has been planting LSFs in Erie County, New York since 2006 in collaboration with the State University of New York, College of Environmental Science and Forestry (SUNY ESF). There are currently more than 5,600 willows and 1,400 conifers planted along more 18,000 feet of the Thruway right-of-way. The New York State Department of Transportation (NYSDOT) also installs permanent and temporary fences and plants living snow-fences throughout the state (Williamson & Volk, 2009).

For LSFs, NYSDOT most often uses hybrid willows but has also used conifers and shrubs. While NYDOT does recognize that several of the species used as snow-fences could have harvest potential as alternative products, none of the NYSDOT regions has explored this opportunity. NYSDOT has also used standing cornrow fences. For snow-fences that must be built on private property, NYSDOT either sets up seasonal contracts for temporary fencing or takes out a permanent easement on private property to site plants or structures.

NYSDOT has also collaborated in several major research projects related to snow-fences. Recently, NYSDOT contracted University of Buffalo and Dr. Ron Tabler to develop a Snow Management software (or SNOWMAN). SNOWMAN allows highway design and maintenance engineers to model options for mitigating blowing-and-drifting snow using snow-fences (Chen and Lamanna, 2008). NYSDOT also collaborates with SUNY ESF on research and SUNY ESF provides technical assistance to NYSDOT designers and maintenance managers. Most recently, a large multiyear research and technology transfer project between SUNY ESF and NYSDOT entitled Designing, Developing and Implementing a Snow-fence Program for New York State implemented several pilot projects and has recently been published (Heavey et al, 2015). NYSDOT employees have also received several trainings with experts such as Ron Tabler from University of Wyoming and SUNY ESF. This ensures that the Department always has several people on the ground with knowledge and background related to snow-fences.

Outreach

Decisions to reach out to landowners are made on a regional basis as needed based on confirmed needs to address blowing-and-drifting snow problems. Each region's approach is slightly different depending upon local staff and regional context. When NYSDOT contacts landowners, outreach is most effective when NYSDOT staff who approach landowners have local connections. NYSDOT's greatest challenge when working with landowners is finding a design that addresses the landowner's needs and the transportation needs of the situation. Sometimes, landowners do not wish to negotiate for permanent plantings or structures because it reduces the usefulness of their lands. Other times, they will allow use of cornrows or temporary fences as these will not interfere with farming or other uses during spring, summer or fall. A general issue in working with landowners whose property adjoins the right of way is to make sure that any work does not cause damage (such as rutting) to the property.

NORTH DAKOTA

In the past, the North Dakota Department of Transportation (NDDOT) collaborated with NRCS and the state Forest Service to implement a snow-fence program. This partnership was initiated after the particularly harsh 1997 winter and utilized federal funding (from FEMA and other sources) to install permanent and temporary fencing along state highways. The program had a million-dollar budget and primarily focused upon living snow-fences. The program covered 100% of the cost involved in planting living snow-fences and also paid landowners $5 per acre for ten years of maintenance, and allowed landowners to receive additional CRP payments. However, in 2009, funding ran out and the partnership dissolved.

Currently, funding for the snow-fence program comes out of NDDOT district operations budgets. As a result, funding for snow-fences has become less prioritized and the program is just a fraction of what it was before with just a handful of participating landowners. Yearly out of five leads for potential fences, one or two sign up for the program. NDDOT no longer installs or maintains temporary or permanent snow fencing but rather focuses efforts on living snow-fences. Landowners sign a 10-year maintenance agreement and NDDOT pays for trees and installation costs. All planting and labor is done by local soil and conservation districts. The landowner receives a single payment for 10 years of maintenance at the beginning of the contract.

Outreach

North Dakota's living snow-fence program annually hires retired NDDOT employee Wayne Wilson as an outreach consultant to reach out to landowners. While he is retired, Mr. Wilson says he likes to do the work and enjoys talking to landowners. NDDOT typically gives Mr. Wilson mile points for areas that are of high priority for snow fencing. He then identifies the exact location of each stretch of road, locates the local landowners using state phone books and the internet, and works with local soil and conservation districts to identify local soil conditions. He will also calculate the approximate payment that each landowner would expect to receive from the program.

Once he has information about approximate payments and the types of trees that thrive in local soil conditions, Wayne will cold-call the landowners about the program. If a landowner is interested, he will visit the site and work with the landowner to pick trees based upon the landowner's preference and local conditions. Once a cultural survey is completed on the land, a contract is signed, and the local conservation district will plant the snow-fence.

OHIO

Ohio has two separate entities that separately work on snow fencing or windbreaks in the state:

Ohio Department of Transportation (ODOT): ODOT has 12 district offices each with a different policy related to snow fencing. Due to Ohio's topography, most of ODOT's snow fencing is found in the Northwest portion of the state. Funding for snow-fences comes from district budgets and nearly all of ODOT's snow fencing is installed on public property. When fencing is installed on private property, it is usually because a local supervisor knows the landowner and has entered into a verbal agreement to install temporary fencing. Temporary wooden or plastic fencing is the most common type of snow-fence used by ODOT. ODOT has also installed permanent snow-fence along 32 miles of state highway, installs LSFs in problem areas around the state and has a standing cornrow program. Living snow-fences are typically composed of pine, red cedar or Norway spruce because they provide dense vegetation and do not grow large-enough to cause a right-of-way problem. For the Corn Row program, ODOT pays the landowner the value of the corn.

Northwest Ohio Windbreak Program: The Windbreak Program is a collaborative effort between local soil and water conservation districts, NRCS, FSA, DOA, Ohio DNR, and Pheasants Forever to protect crops from wind damage, reduce soil erosion, and enhance wildlife habitat. While the program does not focus on snow fencing, over 1,500 windbreaks have been planted covering 6.9 million row feet or 1,300 miles since 1977 because of the initiative.

The program provides funding for up to 90% of the costs of planting the trees and Ohio DNR plants the windbreaks, and applies herbicide. The DNR also guarantees an impressive 100% survival rate of all windbreak plantings. Windbreaks are planted in the spring and in the fall; the DNR does a survival count. Based upon that count the DNR supplies landowners with trees to replace the gaps. If mortality is over a certain percentage, the DNR will return to replant the site. Landowners choose the tree species used in the windbreak and are responsible for site preparation. In addition, once the plantings are established, landowners are responsible for maintaining the trees are also responsible for replacing the windbreaks if they die due to lack of maintenance. Landowners receive payments from both the CRP and Ohio's CRP enhancement program (PREP). CRP payments are based upon soil type and different for each county and the program has strict eligibility requirements. The program only operates in 17 counties in NW Ohio (this part of the state is very flat and mostly agricultural land) and it is strictly an agricultural field windbreak program. In order to be eligible for CRP payments, windbreaks are also required to cover at least 1000 feet and landowners must sign a 15-20-year contract (15 for CRP and 20 for PREP).

Outreach

The windbreak program has mostly been promoted via word-of-mouth between landowners in NW Ohio. Local soil and conservation districts typically are the first organizations to contact landowners. The program has also been promoted in local newsletters or newspapers and on local radio shoes. A windbreak program representative pointed out that while the CRP payments and cost-share is a major factor that allows landowners to participate in the program, individuals who choose to take part also typically have an interest in conservation. To increase participation the windbreak program representative suggested more meetings and public education on existing programs and the benefits of trees.

UTAH

Several different agencies in Utah use snow fencing. Counties throughout Utah have installed permanent snow-fences on local roads. The Utah Division of Forestry also provides advice and assistance to landowners interested in building windbreaks. Foresters provide free assistance drawing up plans and selecting species and can help interested landowners obtain a cost share assistance through NRCS' EQIP program (Williamson & Volk, 2009). Finally, the Utah Department of Transportation (UDOT) also uses permanent wooden and polyester snow-fences as well as living snow-fences to control snowdrift problem areas throughout the state. Living snow-fence species are selected based upon local environmental conditions.

UDOT Maintenance Station Supervisors typically identify blowing-snow problem areas and suggest them as sites of snow-fence projects to regional leadership. When the state constructed the roadways, extra space was bought on the right of ways compared to other states. As a result, UDOT can typically construct the fences on existing state property without needing to engage with private landowners. If UDOT does need to install the fences on private property, it typically will attempt to buy a portion of the land from landowners via an easement. If the landowner is unwilling to sell the property, UDOT will attempt to negotiate other solutions. For example, in Northern Utah UDOT has constructed winter snow berms. After the snow falls, UDOT plows the snow into berms. While these snow, barriers are not as effective as an actual snow-fence, in areas where landowners are unwilling to give up their property they are often the best option.

Outreach

In the mountainous parts of the state, many of the snow-fences are constructed in property managed by state and federal agencies such as the Bureau of Lands. These agencies have different priorities compared to private landowners and are comparatively more likely to support snow-fence construction on their land.

When UDOT has to engage with landowners, the DOT typically sends a representative with some authority in UDOT along with a maintenance supervisor to visit the landowner. UDOT representatives will talk to the landowner about what they would like to do and the potential benefits focusing upon the

safety benefits of the fencing to the local community. If the landowner is amenable to the idea, they negotiate compensation and boundary lines.

Typically, when a landowner agrees to sell his/her property, he/she sees the value of the system for the community's safety. When landowners will not sell their land, it is typically because they do not want to split up the land. In farming communities, small parcels of land can negatively affect farming operations and are an inconvenience when maneuvering around the fencing. Some people also do not like the snow fencing for aesthetic reasons. To overcome this obstacle, UDOT tries to select or paint fences to match the local landscape.

In the future, UDOT suggests educating the public about why the DOT installs the fences. A UDOT representative pointed out that education goes a long way towards gaining public acceptance. It is important for the DOT to be transparent and assure that the public understands what the DOT is doing and trusts that the DOT is acting as a good steward of taxpayer dollars.

VERMONT

VTrans installs temporary snow fencing on public roads during the winter. Vtrans typically identifies blowing-snow problem areas by observing the pre-existing vegetation established along roadsides. VTrans has found that existing vegetation (trees bushes etc.…) can act as a living snow-fence and in many areas where blowing-snow is an issue the vegetation/ground cover has been removed for agriculture, fields etc... Typically, when VTrans installs temporary fencing, landowners sign a temporary easement contract and are not paid for the service. All funding for installation, removal, and materials comes from the agency. However, the Agency has been getting more and more pushback from landowners that do not want the fencing on their land. The main reasons for landowner reluctance are fear of liability, fear that the fence will damage their property or crops, and general mistrust of government. As a result, VTrans installs less fencing than in the past. In rural areas, local people are more likely to allow the fences on second tier roads. This sustained interest is more "community based" as local community members want to ensure the safety of local roads. VTrans has received some complaints about poor road conditions as a result of the decreased use of snow fencing and is also looking into planting living snow-fences along the right of way on public roads in the future.

WASHINGTON

While Washington has no statewide program, several communities in the state have used snow-fences to control snowdrifts. For example, temporary snow-fences have been used in Western Washington and there have been several living snow-fences constructed in the state. In Lincoln County Washington, two living snow-fences were established in partnership with the USDA national Agroforestry Center, NRCS, Lincoln County Conservation District, Washington Department of Fish and Wildlife and WSDOT (Williamson & Volk, 2009). In Lincoln County, NRCS and CRP provided funding for the two demonstration fences that were constructed in 2003 and 2007. Maintaining the fences in the area has been difficult due to the arid terrain and frequent fires.

WISCONSIN

WisDOT uses snow-fences throughout the state as a means of preventing winter crashes while reducing snow removal costs. WisDOT identifies Blowing-snow problem areas by reaching out to staff in each of WisDOT's five regions as well as county commissioners and by reviewing data on major crashes and areas with high crash rates related to winter weather. Sites are prioritized based upon regional staff requests, the severity of the blowing-snow problem, or on a first-come-first served basis.

WisDOT's standing cornrow program has been in place since 2011. The program pays landowners 50 cents more per bushel than market price to leave rows of corn unharvested in the winter. Landowners sign a seasonal contract and receive an upfront payment at the beginning of the season. WisDOT has also collaborated with community groups such as girl scouts to pick the corn and sell it at a local mill. The landowners can use the donated corn as a tax write-off. Currently about 12 landowners participate in the cornrow program.

WisDOT has also been focusing much of its efforts on living snow-fences due to the comparatively high cost: benefit ratio associated with these plantings (CTS, 2015) and the fact that WisDOT has funding for roadside plantings that can be used for snow-fences. Currently all living snow-fences have been installed on state-property as no landowners have consented to putting the fences on their land. Lately, WisDOT has been focusing upon purchasing permanent easements rather than engaging in temporary contracts with landowners in order to ensure the long-term persistence of snow-fences. Snow fencing requires an investment of time and money to establish and these benefits are lost if the landowner does not renew the contract. For plantings, WisDOT uses native species that do not grow to more than four inches in diameter and are unattractive to deer due to the risk of car impact. WisDOT also installs temporary or permanent snow fencing throughout the state on roads that are not appropriate for living snow-fences.

Outreach

WisDOT typically identifies locations of interest for snow-fences and then hires out the implementation work to local counties. In most cases, county staff approach landowners in high-problem areas although landowners have also directly contacted WisDOT about the cornrow program. When speaking with landowners county staff have found it effective to speak about the safety benefits of the fences for the local community.

Local landowners that participate in the cornrow program recognize how bad the snow near their property gets and realize that the snow-fences prevent snowdrifts on roadways. In addition, landowners in the cornrow program essentially are paid for the same crop twice. If crop yields are poor for a season, landowners often decide to participate because they realize they will make more money. The main obstacle to participation is often inconvenience of needing to break out or rent combines to process a short stretch of property in the spring. This seems to especially be the case for large-scale operations and WisDOT has noticed that smaller farms tend to be the ones that step forward to participate in the cornrow program.

In the future, WisDOT would like to collaborate with more community organizations such as local police or fire departments to help promote the snow-fences from a safety standpoint in their communities.

WYOMING

Because Wyoming's state and interstate roadways are relatively remote and characterized by strong winds and open terrain, snow-fences are seen as a cost-effective means of ensuring public safety. Besides maintaining permanent snow-fences on public highways , Wyoming Department of Transportation (WYDOT) collaborates with the Wyoming State Forestry Division (WSFD), conservation districts and landowners to implement a living snow-fence program. WYDOT provides $100,000 in funding annually and WSFD oversees the program. Program outreach, design, and implementation is conducted by local conservation districts. Prior to construction, an outside committee reviews snow-fence projects.

When identifying blowing-snow problem areas, WYDOT relies upon maintenance crew leaders for input about road conditions and where the most resources are spent to keep roads open and accessible. WYDOT has a winter research team that has developed a good relationship with maintenance forces throughout the state. Once the relationship was established, maintenance crews began to reach out to the winter research team with trouble spots. Once a potential site is identified, information is gathered including prevailing winds, amount of snowfall and accumulation, crash history, and landowner involvement. The Winter Research team uses this information to recommend priority areas to WYDOT's District Leadership.

Participating landowners sign a 30-year contract and WYDOT pays for all material installation and initial maintenance costs. Local conservation districts design and install the plantings and maintain the trees until they are established. Once established, the snow-fences are handed over to the landowner to maintain the plantings. However, in the case of an event such as fire or insect pests that destroy the plantings, the landowners are not financially responsible for replacing the trees and the conservation district can reach out to WYDOT for funding to replace the fence.

Outreach

Outreach for the living snow-fence program is highly targeted based upon sites of concern. WYDOT typically identifies problem areas on public roads that would benefit from a snow-fence and communicates this information to local conservation districts. Conservation district employees already have established relationships with people in the area and individually approach landowners. Most conservation district employees are also from the local community that makes it easier for them to contact and speak with landowners. The conservation district representatives sit down face to face with landowners, give them the pros and cons of the snow-fences and map out the project. In addition, in many communities landowners are already aware of the snow-fence program before being contacted by the conservation district because the program has been operating in the area for several decades.

In Wyoming, landowners respond positively to the fact that the snow-fences provide shelter for livestock and wildlife and help ensure safe travel for the local community. The snow-fence program does very little general outreach and not much information is available online. Rather conservation districts focus their efforts upon developing relationships with several large-landowners on high priority roads to ensure that these roads have long stretches of continuous fencing.

CANCELLED PROGRAMS

Nebraska

Nebraska's snow-fence program was discontinued due to lack of funding. It was a cost-share program, which planted living snow-fences along state highways through the Nebraska Forest Service, and Forest Land Enhancement Program (FLEP). The program was also funded by several federal sources of funding including federal roads funding and the CRP. The program reimbursed participants from 50-70 percent of costs (FLEP, 2015). Local natural resource districts helped to promote the program and it was very popular in the mid to late 1990s. It was especially popular in the western 2/3s of the state. However, funding ran out and lack of funding turned into lack of interest and many of the projects have fallen by the wayside since the program's heyday. Today, some local counties occasionally install temporary snow-fences when necessary. In the future, the Nebraska Department of Roads would be open to the idea of snow-fences and sees and opportunity to work with landowners to install LSFs through the federal CRP. However, there are currently no plants to re-establish the program in the state.

Pennsylvania

While temporary snow fencing was once very common in Pennsylvania as a program implemented by the Department of Transportation, it has since lost its popularity and is no longer implemented (Wenner, 2010).

South Dakota

There have been snow-fences established in over 24 counties in South Dakota covering over 180 acres and protecting about 13.5 miles of highway from drifting snow (Williamson & Volk, 2009). However, recently the funding that SDDOT previously used for its snow-fence program ran out and the program has been cut.

In the past SDDOT, the South Dakota Department of Agriculture, the South Dakota Department of Resource Conservation and local conservation districts identified critical areas along transportation routes for living snow-fence placement. If landowners agreed to provide the property for a living snow-fence, they signed 10-year contracts and were responsible for maintaining the trees. The program was a cost-share program where SDDOT paid for site preparation, 20% of the cost of the trees, planting, five years of maintenance, two years of replanting and paid the landowner easement payments based upon the cash rental value of the property for 10 years (Williamson & Volk).

However, over time landowner, interest in the snow-fence program began to wane and it became increasingly more difficult to coordinate with landowners and convince them to have the fences on their property. Lack of landowner interest combined with lack of funding contributed to the cancellation of the program. According to an SDDOT representative, while it is unlikely that the living snow-fence program will restart, snow-fences are still on SDDOT's menu of options for addressing snow buildup in problem areas.

STATES WITH OTHER WINDBREAK/CONSERVATION PROGRAMS

Alaska

While Alaska does not specifically have a snow-fence program, the cities of Ketchikan and Sitka offer grants as well as technical support for the inventory and management of trees. The community forestry program offers hands on help, as well as publications that include information on the management of trees for windbreaks and snow-fences (Alaska DNR, 2015).

Indiana

In Indiana, landowners participate in the federal CRP and often plant windbreaks that sometimes can also serve as snow-fences (Williamson & Volk, 2009).

Kansas

The Kansas Forest Service's Conservation Tree Planting Program sells tree and shrub seedlings to be used in conservation plantings. This program includes trees to be used as windbreaks but does not focus on windbreaks specifically. While Kansas Forest Service provides information about snow-fences, the conservation tree-planting program does not specifically promote snow-fences (KFS, 2015).

STATES WITH SNOW-FENCES IN A MOUNTAIN SITE

Arizona

ADOT utilizes permanent snow-fences in strategic areas in the Northeastern part of the state in order to improve road conditions and reduce the need for plowing/chemical maintenances during winter storms (ADOT, 2014). These fences are constructed and maintained by the state with no local community involvement.

California

The state of California has installed "jet roofs" on Carson Pass in the Sierra Nevada Mountain Range. These jet roofs act like snow-fences and alter wind patterns to prevent the development of snow cornices that can give way and cause avalanches onto nearby highways. There is no public involvement or outreach regarding these structures (Caltrans, 1999)

APPENDIX B:
STATE SNOWFENCE PROGRAM (CHAPTER 3) INTERVIEW GUIDE

Expanding the Adoption on Private Lands: Blowing-and-drifting Snow-control Treatments and the Cost Effectiveness of Permanent versus Non-Permanent Treatment Options.

Objective: Reach out to snow-fence programs in other states and in Minnesota about landowner adoption in similar-snow-fence programs throughout the United States.

Interview Questions:

General Program Description

- What types of snow-fence does the program promote (permanent, temporary, native trees/shrubs, standing corn etc.)?
- For fences using plants, what species are used and why?
- Do any of the plants (other than corn) in living fences have potential for harvesting/production for sale?
- How old is the program?
- How many landowners currently participate in the program?
- Where is the program offered in the state?
- Who manages the program?
- Do you collaborate with any other local, state or regional agencies to implement the program?
- Where does program funding come from?
- How long is the contract/commitment for participants who enroll in the program?
- How long do landowners typically stay in the program?

Landowner Engagement/Adoption Questions:

- How do you identify/target landowners for the program?
- How do program participants typically learn about the project?
- How does the program reach out to and recruit participants?
- What has the program done to encourage landowner participation?
- What incentives (financial, technical etc.) does the program offer participants?

- What type of support does the program provide to participants?
- How much interaction does the program have with participants that have signed up?

Program Strengths/Opportunities

- Why do you think landowners choose to participate in the program?
- What do you see as the strengths of the program in terms of engaging landowners?
- What would you do in the future to increase landowner adoption?

Program Weaknesses/Challenges

- Why do you think landowners choose not to participate in the program?
- What do you see as the program's greatest challenges related to landowner participation?
- Is there anything that you would do differently to improve the program or improve landowner participation?

APPENDIX C:
EXAMPLE MATERIALS FROM STATE SNOW-FENCE PROGRAMS

SNOW-FENCE WEBSITE

- Colorado State Seedling Tree Program:
  - http://csfs.colostate.edu/districts/fort-morgan-district/fort-morgan-seedling-trees/
- Colorado State Seedling Tree Nursery:
  - http://csfs.colostate.edu/seedling-tree-nursery/
- Colorado State Extension
  - http://www.ext.colostate.edu/sam/windbreaks.html
- New York State Department of Transportation:
  - https://www.dot.ny.gov/divisions/engineering/design/landscape/trees/rs_liv_sn_fence
- Iowa Department of Transportation:
  - http://www.iowadot.gov/maintenance/snowfence.html
- Wyoming State Forestry Division
  - https://sites.google.com/a/wyo.gov/living-snow-fence/home

SNOW-FENCE PROGRAM BROCHURES

- McHenry County Living Snow-fence Program Brochure
  - https://www.co.mchenry.il.us/home/showdocument?id=24149
- Iowa Department of Transportation's Living Snow-fence Program:
  - http://www.iowadot.gov/maintenance/pdf/snowfencebooklet.pdf
- Ohio DNR Windbreak Brochure
  - http://forestry.ohiodnr.gov/portals/forestry/pdfs/windbreaksguide.pdf
- South Dakota Department of Agriculture Snow-fence Brochure
  - https://sdda.sd.gov/legacydocs/Forestry/publications/PDF/LSF-Brochure.pdf
- Nebraska Forest Land Enhancement Program
  - http://www.nfs.unl.edu/documents/flep%20brochure2.pdf

SAMPLE CONTRACTS

- McHenry County Division of Transportation Standing Corn Row Agreement:
  - https://www.co.mchenry.il.us/home/showdocument?id=24151
- North Dakota Forest Service Windbreak Renovation Grant Program In-kind Match Values
  - https://www.ag.ndsu.edu/ndfs/documents/renovation-in-kind-rates.pdf
- Wyoming State Forestry Division
  - https://sites.google.com/a/wyo.gov/living-snow-fence/
  - https://drive.google.com/file/d/0B5MoU4cZTAwcZno0MTFmc3VqbGc/edit
- Northwest Ohio Windbreak Program windbreak procedures and guide
  - http://forestry.ohiodnr.gov/portals/forestry/pdfs/windbreakprocedures.pdf
  - http://forestry.ohiodnr.gov/portals/forestry/pdfs/windbreaksguide.pdf

DESIGN GUIDES

- Iowa http://www.extension.iastate.edu/forestry/publications/PDF_files/SHRP-H-320.pdf
- New York http://www.esf.edu/willow/lsf/documents/3LivingSnowFenceDesign.pdf

APPENDIX D:
NYSDOT SNOW-FENCE TRAINING MATERIALS

Training PDFs

- Volk et al. (2009). NYSDOT Snow-fence Training. SUNY Buffalo Retrieved from: httWps://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/SnowFenceTraningOct2009_slides.pdf
- Volk et al. (2011). NYSDOT Snow-fence Training. SUNY ESF. Retrieve From: http://www.esf.edu/willow/lsf/Presentations/LSF%20Design%20Training.pdf
- Volk et al. (2012). NYSDOT Willow Snow-fence Training Program. SUNY ESF. Retrieved from: http://www.esf.edu/willow/lsf/Presentations/LSF%20Installation%20Training.pdf

Training Descriptions

- Living Snow-fence Training in Buffalo, NY. (2009). Retrieved from: https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/LivingSnowFenceDesignTraining_October2009.pdf
- Heavey et al. (2015). Designing, Developing and Implementing a Living Snow-fence Program for New York State. SUNY ESF Retrieved from: http://www.utrc2.org/sites/default/files/FinalReport-Living-Snow-Fence-Program-NYS_0.pdf

Funding Proposals

- Living Snow-fences. (2007) Project Proposal submitted to the University Transportation Research Center. Retrieved from: http://www.utrc2.org/sites/default/files/files/c0609-living-snow-fences.pdf

Additional Materials:

- Willow Living Snow-fences. SUNY ESF Website. Retrieved from: http://www.esf.edu/willow/lsf/

APPENDIX E
NOTES FROM AUGUST 10 MEETING WITH MAINTENANCE STAFF TO DISCUSS PROMOTIONAL PROGRAM

Wednesday, August 10, 2016, 9-12:30

MnDOT Office – Willmar, MN

Meeting notes:

Participants

MnDOT District 8		Organizers
Craig Gertsema	Joel Johnson	Dan Gullickson
Tim Leland	Denny Marty	Gary Wyatt
Emily Randt	Kyle Gosmann	Dean Current
Van Zwettler	Jeff Baker	
Rick Reigstad	Ted Ziemann	
Jason Menz	Shannon Wait	

Contacts:

Started the discussion asking how many had contacted landowners and County SWCD offices. Jason had contacted several landowners formally or informally and had three ready to sign up and another 5-6 that were interested. He has also contacted the local SWCD office and talked to one of their employees. One of the SWCD Board members had shown interest, which might be a good way to spread the word through the SWCD. Jeff had made some contacts but did not mention any sign-ups yet. Rick had identified an interested farmer – may have been renter. In summary, some contacts had been made but most of the group had not contacted landowners or SWCD's. Positive point was that there are already three landowners ready to sign. It seemed that Jason is well known in the community, which has helped him make contacts and interest landowners in snow-control.

Denny talked about a farmer that had been in the program for 4-5 years but had decided not to c o n t i n u e because it was a hassle to farm around the snow-fence (cornrows?). This led to a discussion of the large farms and larger machinery and the comment, again from Jeff and generally agreed upon, that the money received by a larger operator did not mean much and that the benefit to the community might have a greater influence on their interest in implementing snow-control. The inconvenience of farming around the fence was greater than the potential financial benefit.

Jason had mentioned that most of the landowners he contacted were not aware of the program. Dan mentioned that that was similar to what we found with the focus groups from our previous project. Many people are not aware of the program.

Promotion:

Van mentioned that many plow drivers might not live in the communities where they are plowing snow so do not know the landowners. Later in the morning it was suggested that it would be good to "put a face on the plow" meaning that it would be good for folks on the plow route to meet or be aware of who t h e i r plow driver was. This could be part of the rollout of the promotional program. This could also be part of the January focus groups to have the plow drivers there and talk about problem areas with the landowners. Emily suggested there also be a Farm Fest booth maybe as part of a MnDOT booth or a snow-control booth. Gary agreed with the Farm Fest booth and suggested we try to coordinate with FSA and NRCS.

Rick mentioned that we should be talking to farmers/landowners/renters before they plant. Jason also suggested we talk to seed dealers as they have close contact with farmers. During break, Van suggested that insurance agents might also help with promotion as they work with all farmers and may even have an interest in avoiding accidents during snow events. Another group we might want to contact would be land managers that manage farmland for the owners. Those contacts could be part of a project amendment to interview landowners.

Dan mentioned that plow driver snow-control representatives should be able to tell a landowner what the MnDOT offer is when they meet them to facilitate the process and avoid a long drawn out process t o contract a snow-control measure. He mentioned that getting and easement to deal with blowing-snow problems was a long drawn out process that could take over a year so not a good option. Standing cornrows should be a quick relatively hassle-free process.

Business cards for plow operators and working with landowners:

Everyone seemed to like the business cards and liked that the supervisor's phone number was on the card. Joel thought the cards were good as they were and felt there was no need for a special title. Discussed being able to approach farmers and, if the plow driver did not know the answer to a question, they could note the question and tell the landowner they would get back to them with an answer later. Jason also suggested getting the name and number of the landowner whenever a contact is made to contact them later.

Shannon said she could get cards prepared within a week. (This has been completed.)

Number of cornrows:

There was a discussion about the number of standing cornrows that are required for an effective snow-fence. Denny mentioned that they had had an experience where 6-8 cornrows were flattened by a strong wind removing the protection that the fence provided and suggested 12-18 rows. Either Denny or someone else commented that when there is no snow on the ground there is a greater chance that a wind can flatten the cornrows. Jeff said that if you have Pioneer corn, there is a greater likelihood that it will blow down. Van suggested that if the corn blows down landowners will lose interest since there would be no effect.

This led to a discussion of landowner interest and the severity of the winter. If a snow-fence is established and we have a mild winter, landowners do not see an impact. Denny said that if landowners see a benefit, they would sign up. Dan said there must be a personal interest and Shannon told her story about her work with a landowner in District 6 that wintered in Arizona and was not interested until Shannon talked about their employees not being able to get to work or having to deal with the blowing-snow and that was enough to convince the landowner to put in a fence/standing corn rows.

Joel said that the farmers like to "put a face to the snowplow", maybe even a flyer with a picture of the driver or part of the door hanger. He also said that this supervisors name should be on the card. Jeff asked about what material would be available for promotion. Denny thought that farm fest would be the best spot for advertising and Shannon also mentioned the State Fair is another option. Craig thought that the State Fair might be difficult since MnDOT might be pursuing other agendas there. Jeff suggested that if we have a poster we could add other options to it besides the standing cornrows.

Hay bales and plastic fencing:

Jeff also suggested that we need to be flexible in terms of how we use hay bales. Putting them in a pile o f two is difficult and 90% of the time farmers are more interested in a single roll. There was a discussion about also using the plastic snow-fences. Dan said that MnDOT used to put up about a thousand miles of fence every year. Van added that plastic fence works well and in one case MnDOT provides the maintenance. Dan mentioned that in District 6, a farmer had purchased a fence and MnDOT paid them per lineal foot. Dan did add though that a plastic fence will fill up and once it is full, will not be effective.

Signing up vendors:

Jason raised the issue of signing up farmers and the process required. He was wondering if farmers could call the MnDOT office to be able to get assistance with signing up for being a vendor. Denny and Craig thought that that might work. The business office has offered to help wherever they can.

Hay bales/variable payments:

Denny mentioned that when they put up stacks of two hay bales they pay the landowner more for the extra work. Jeff suggested that on a difficult site that MnDOT should be able to pay more but there was a concern that the neighbors might wonder why one person was being paid more than another was.

Shannon mentioned that in district 6, they had been able to negotiate the price for standing cornrows. Gary asked about hay equivalents to a standing cornrow. Emily suggested that anyway we could help farmers more will make it easier to sell the program.

Liability and cropping issues:

Craig was wondering whether, if MnDOT does work on a farmer's land, if there might be some liability issues if someone gets hurt or the property is damaged. Tim said that he worked with many dairy farmers while Emily said most of the farmers she works with would be corn and beans. Gary mentioned

that there are farms with both beans and corn that plant in strips, so they always have standing cornrows on Highway 30. On promotion, Jason mentioned that he had talked to some farmers when he saw them in town and mentioned that he knew many people in the community and that it helped sign-up some farmers. There was also discussion about how we might work with farmers to plant peas. One option might be Sorghum Sudan grass or another tall cover crop after the peas are harvested. It was mentioned that equip does provide payments for cover crops and that could help. Jason mentioned that there is a lot of peas in Renville County. **Note: we need different options for different types of farmers and crops.**

Cost estimate tool issue:

Jeff mentioned that people often think about the plow driver's work for the county and asked him about accounting issues. Danny brought up one issue with the cost estimate tool. He said that if he goes out on a plow route and treats more than one area on the same trip, the tool is inaccurate because it assumes a separate trip for each problem area. Dan mentioned that it is just a tool, and everyone needs to use their judgment as they interpret results.

Options and setback issues with larger farms:

Someone asked if we need to add a price for bales to present the farmers and Craig thought that would work. Jeff suggested that we need to mention a setback distance from the field edge and that will be somewhat determined by the equipment of the farmer and Kyle suggests that we have to work with them on that and be flexible. **Ted suggested that the best time to talk to farmers is in the winter when there actually is a snow problem**. Jeff discussed some issues that larger farmers with large equipment have when leaving a setback and maneuvering around it. He drives truck for some of the local farmers and has a good understanding of issues.

Promotion issues:

Van suggested that we might want to **work with insurance agents** as they might be etched in seeing the number of accidents reduced. Jason mentioned again that, based on his conversations, people are not aware of the snow-fence programs. He also asked about the number of posters and other written material might be available.

Harvesting corn from corn rows – 4H/FFA/Checklist for farmer visit and follow-up

We moved on to discussing working with 4H and FFA to do the corn picking for the standing cornrow program. Joel asked about MnDOT's role in the agreements for corn picking and was concerned about liability issues. We moved on to discuss the checklist. Two questions came out of the discussion of the checklist. One, is there a need for W9, and two, will it be possible for landowners to call MnDOT to get set up as vendors. We later talked to the business office and they indicated a W9 is needed for a vendor. For the checklist, it was suggested that there be a question about whether or not the farmer is already a state vendor. Gary said he would send out a revised checklist this week.

Number of cornrows:

There was a question about whether or not we need to have more than six rows of corn. Denny mentioned that he had put up a six-row standing cornrow snow-fence and it had blown down and he felt like he got burnt and would not be doing that again.

Dan talked about the segment ID in the neck unique identifier that would be needed for doing a cost-benefit analysis and for identifying the segment.

Next steps:

- We need to identify sites for Shannon to run the cost-benefit tool
- Add an area for notes and comments to the cost-benefit tool worksheet.
- Get the business cards printed.
- Craig suggested that tool was not a prerequisite for the contract. He would let the plow drivers make the call on whether or not the snow-fences needed.
- We talked about putting the posters out after Labor Day someone mentioned that the beet harvest had already started. It seems that, with the variety crops are grown across the district, the promotional program will have to be adjusted to take that into account and adjust promotional activities to the harvest schedules.

Important points to consider:

- We need a way to keep the dialogue going and make sure that those present start contacting landowners and local SWCD offices.
- "Meet your plow driver" might be something we can work on with flyers or public meetings/focus groups.
- Financial incentive and "Civic duty" as motivators for different landowners/renters
- As we have seen in the past, many farmers in the community are not aware of the snow-fence program. What is the best way to get the word out? Mandi should be able to help with this.
- We will probably need to tailor the program and options to address both large farms and smaller farms as well as the different cropping systems in District 8 and elsewhere. The approach may change with the plow route and within plow routes depending on the farm type and crops.

APPENDIX F:
PROMOTIONAL MATERIALS

- Farmer meeting(s) form
- Cost benefit tool inputs
- Post card for farmer
- Photos of snow-control options for farmer
- Talking points for meeting with farmer
- Vendor registration post card
- Vendor registration screens for on-line sign up
- Standing corn rows door hanger
- Community poster
- Promotional and educational plan

APPENDIX G:
PLANTING AND HARVESTING ALTERNATIVE PRODUCTS FROM SNOW-FENCES

Results from 1999 Focus Group Study related to interest of landowners in producing an additional crop from a snow-fence. (From Petersen, 1999)

MARKETABLE CROPS FROM A SNOW-FENCE

KEY FINDINGS

The farmers who attended and participated in the focus groups were not in favor of planting and harvesting alternative crops in the land set-aside for a snow-fence.

Discussion

The farmers were asked whether they would consider making additional income off products planted near the snow-fence including:

- Native grass and wildflower seed,
- Native grass straw mulch,
- Handicraft materials for the floral industry,
- Nuts and/or berries,
- Medicinal material such as ginseng, Echinacea, etc., or
- Specialty commercial mushrooms.

The farmers who attended and participated in the focus groups were not in favor of the idea of planting and harvesting alternative crops in the land set-aside for a Snow-fence.

The advantage mentioned was:

It would be a positive, especially if it was a plant with fruit or something esthetically pleasing;

The concerns mentioned included:

- the crops would likely have harvesting times inconsistent with other crops;
- chemical sprays used would not allow consumption of edible products;
- it would be more of a hassle than its worth, and most farmers would not have enough time to harvest and maintain; and
- If you harvested the grasses, it would lose its effectiveness for catching snow, and if there were ice, it would flatten the grasses

APPENDIX H:
DECISION SUPPORT TOOLS FOR ALTERNATIVE CROPS

Elderberry Financial Decision Support Tool
http://www.centerforagroforestry.org/profit/elderberryedmcurrent.xls
Larry Godsey, Center Economist
University of Missouri Center for Agroforestry
godseyl@missouri.edu

Black Walnut Financial Model
http://www.centerforagroforestry.org/profit/blkwaldst.xls
http://www.centerforagroforestry.org/profit/walnutfinancialmodel.xls
Larry Godsey, Center Economist
University of Missouri Center for Agroforestry
godseyl@missouri.edu

Midwest Hazelnut Enterprise Budget Tool
http://www.midwesthazelnuts.org/assets/files/hazelnut%20enterprise%20budget_beta.xlsm
Jason Fischbach, Agriculture Agent
Ashland and Bayfield County UW-Extension
jason.fischbach@ces.uwex.edu

Agroforestry Production Development Tool
http://agroforestry.ubcfarm.ubc.ca/agroforestry-production-development-tool/
Kate Menzies
Kate.menzies@ubc.ca

APPENDIX I:
BASIC DATA USED FOR THE FINANCIAL ANALYSIS OF SNOW-FENCE OPTIONS

Note: all fences are 1,329 feet long but have varying widths, so each option offers comparable protection from blowing-and-drifting snow. [18]

1) Standing Corn Rows (Renville County) -
    a. 50-foot-wide - 1.5 acre
    b. MnDOT payment - $1,500 per acre
    c. Cost of planting corn - $617 per acre (From UMN Extension-Estimate 2017)
    d. Total area taken out of production – 1.5 acres

2) Living snow-fence enrolled in CRP where snow catch area cropped.
    a. 50-foot-wide snow-fence area and 150-foot-wide cropped area
    b. 1.5 acre living snow-fence USDA CRP payment @ $250/acre
    c. MnDOT Maintenance. 1.5-acre fence area @$155/acre
    d. MnDOT snow storage payment on 4.5 acres @ $125/acre
    e. Total area taken out of production – 1.5 acres

3) Living snow-fence enrolled in CRP with snow catch area planted to grasses and flowering plants and also enrolled in CRP
    a. 50 ft. wide snow-fence area and 150-foot-wide snow catch area planted to native grasses enrolled in CRP
    b. 1.5 acre living snow-fence USDA CRP payment @ $250/acre
    c. Snow catch planted to CRP, 4.5 acres @ $250/acre - CRP payment
    d. Snow catch area planted to CRP, 4.5 acres @ $250/acre - MnDOT
    e. Maintenance at $155 per acre for 6 acres (fence and storage)
    f. Total area taken out of production – 6 acres

4) Structural Snow-fence
    a. Long-term structure with footings 4 ft. or greater in length. Cost of fence covered by MnDOT
    b. Cost of fence @ $30 per foot
    c. MnDOT annual payment $1.00 per foot
    d. Total area taken out of production – 0.75 acres

[18] Information provided by Dan Gullickson of MnDOT